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FIRST-AID MOVEMENT IN THE ANTHRACITE REGION OF PENNSYLVANIA.

By H. H. Stoek.

THE ENGINEERING MAGAZINE is sincerely glad to have this opportunity of furthering a movement so important, to the nation and to humanity, as that which aims to minimize the loss through death and injury to coal miners. It is an added satisfaction to render this office to the movement through co-operation with so excellent an authority as Mr. Stoek, editor of *Mines and Minerals*.—THE EDITORS.

IN all that has been written and said of late about conserving the Nation's resources and the prevention of accidents, one means of conservation has been largely overlooked. This is the rendering of first aid to those who are injured, in order that the injury may not prove fatal, or that persons may not be permanently disabled. When a person receives a severe electric shock, is overcome by smoke, or is rescued from the water, how few, if any of the sympathetic by-standers can render intelligent assistance.

In European countries it is incumbent on every policeman and every fireman to be able to render first aid; and in England, a St. John's Ambulance certificate is a prerequisite to employment in an official capacity in certain branches of industry.

In the United States, although all are justly proud of her leading position as an industrial nation, the death and accident lists are far in excess of those in most European countries. It is not necessary here to consider the causes for this state of affairs, but that we kill and injure more people for a given number of employees than is done abroad, is undoubted. This fact alone offers sufficient excuse for instructing certain classes of employees so that they can render immediate and intelligent assistance in case of accident.

A gratifying exception to the general absence of such knowledge in connection with industrial pursuits is to be found in the anthracite mining region of Pennsylvania, where a very complete and efficient first-aid system has been developed and is being maintained by the companies operating the anthracite mines. Give even a coal baron his dues; for it is not true, as is so often erroneously stated, that "the life of a mule is considered of more value than that of a man."

FIG. I. CHAMPION FIRST-AID TEAM, HILLSIDE COAL & IRON CO. AND PENNA. COAL CO.

Such dire disasters as Monongah, Darr, and Marianna, although they make the most impression upon the general public, are fortunately rare. It is an unfortunate fact, however, that the grim reaper is never idle in a mining community and the dreadful total of mine casualties is a summation of many accidents in which one, two, or mayhap half a dozen are killed or injured. It is this steady stream of casualties that worries the mine manager more than the greater calamities that attract the public attention, for while the conditions in most of the mines are such that great casualties are not likely to occur, minor accidents are everywhere of more or less frequent occurrence.

For every person killed in the mines several are injured, more or less severely, and relief measures promptly and intelligently applied may prevent death, or may lessen the after effects due to blood poisoning or to delay in securing the services of a surgeon. The sur-

roundings in a mine are dirty and the clothes and hands of the workmen are necessarily soiled, so that no matter how careful his fellow workmen may be, a slight injury may be greatly aggravated through unskilful handling, because there is frequently a considerable period between the occurrence of the accident and the time when the physician sees the patient, owing to the remoteness of the working places in many mines, and to the difficulty in transporting an injured person to the surface.

The campaign for preventing accidents now being carried on by the United States Government and the several State departments of mines is of great importance, and credit should be given to those engaged in so laudable a work. The fact should not be overlooked, however, that before popular attention had been called to such work by a series of most distressing accidents many of the coal companies had well equipped hospitals in the mines, and in the anthracite region at least there were regularly drilled and efficient First Aid corps trained to render immediate assistance in case of accident. Furthermore, it should be remembered that the organization of such corps was a voluntary matter on the part of the coal companies, for, excepting the laws in some States requiring mine hospitals, there is at present no State or Federal regulation requiring first-aid work, as there is abroad.

In 1901 the legislature of Pennsylvania passed an act making it unlawful to operate an anthracite mine employing 10 men or more unless sufficient supplies for rendering first aid in case of accident were stored in a room located in some convenient place in the mine. This room was required to be not less than 8 feet by 12 feet in size, lighted, clean, well ventilated and furnished to accommodate two or more persons in a reclining or sitting posture. The hospitals installed by the mining companies as a result of this law, and maintained by them ever since, fulfil not only the letter of the law, but its spirit as well, for they are usually larger than the legal requirements, and the maintenance of good hospitals has become a matter of pride with the anthracite companies. (Figure 2, page 324.) The appliances are simple so that they can be easily kept clean, and the equipment usually consists of one or two tables which are either stationary or movable, a reclining Morris chair, stretchers, and a box of supplies which is usually very much more complete than is required by law. Whenever possible, the underground hospitals are heated by steam, lighted by electricity, and are provided with hot and cold running water, and the floor, at least, is cemented and all of the walls throughout are whitewashed.

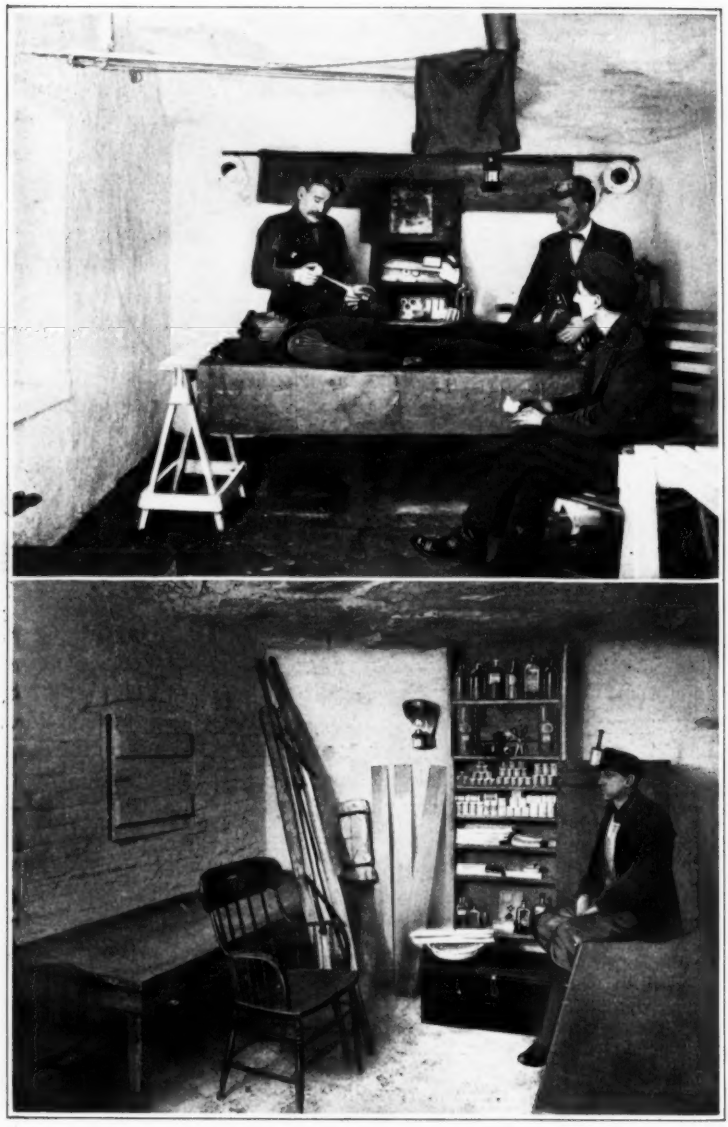


FIG. 2. TYPICAL MINE HOSPITALS IN THE ANTHRACITE REGION.

In order that injured men may be carried from the place of injury to the inside hospital or to the surface with a minimum of discomfort, the Lehigh Valley Coal Company uses an ambulance mine car. The frame of the car is similar to an ordinary mine car, but the central portion is supported on wire springs so as to reduce the jarring to a minimum. In each car there are two upholstered stretchers *a* covered with oilcloth. The handles *b* slide in grooves and the sides *c* of the car are removable so that the stretchers can be readily taken off either side. At each end there are two seats for attendants, and between these there is space in which a first-aid box can be placed. (Figure 3.)

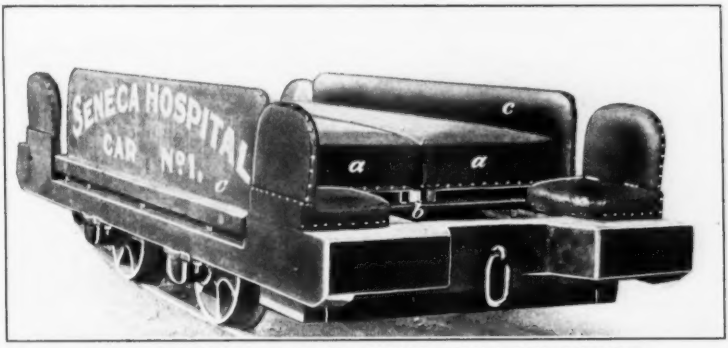


FIG. 3. AMBULANCE MINE CAR, LEHIGH VALLEY COAL COMPANY.

In addition to the underground hospitals required by law, some of the coal companies maintain similar hospitals upon the surface.

The D. L. & W. Co. in addition to its underground hospitals has a hospital car (Figure 4, page 326). This consists of a passenger coach which has been transformed into an ideal hospital car containing six beds covered with black enameled cloth which can be washed and thus kept clean. A capacious closet contains all necessary medicines, surgical appliances, and dressings for emergency work; four stretchers are also provided. This car is located at a central point to the mines of the Lackawanna Company and can reach any of the mines within a short time after an accident. By means of it, when once a man is placed upon a stretcher, he need not be removed until he is placed in his bed at home or in a hospital on the surface.

Through the munificence of Mr. Moses Taylor, who was closely identified with the Lackawanna Railroad, a large hospital known as "The Moses Taylor Hospital" was erected in Scranton, in which all the employees and their families are treated without charge.

Although the law provides for hospitals underground and makes it the duty of the mine foreman and his assistants to see that an injured person is properly cared for and removed to the underground hospital, and thence to his home or to a hospital on the surface, there is no direct provision requiring the training of foremen and other officials in first-aid methods, and the organization of systematic training has in most cases grown out of the desire on the part of the coal-company officials to utilize as efficiently as possible the equipment they are required by law to maintain. Each of the coal companies has developed an organization that it considers best suited to its own needs, but it is not necessary here to go into the minute details of these various organizations, and only the general features of the work need be considered.

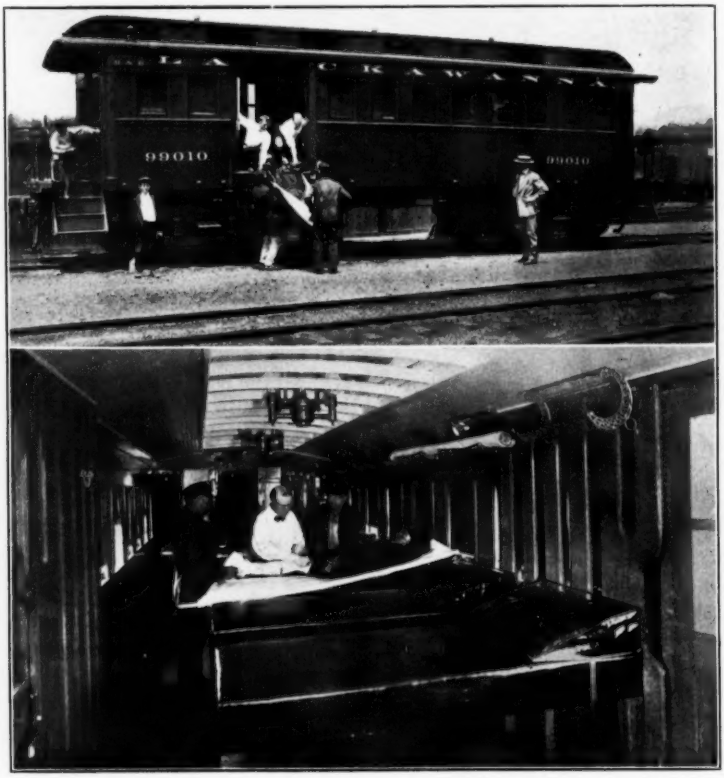


FIG. 4. HOSPITAL CAR, D. L. & W. COMPANY. EXTERIOR AND INTERIOR VIEWS.

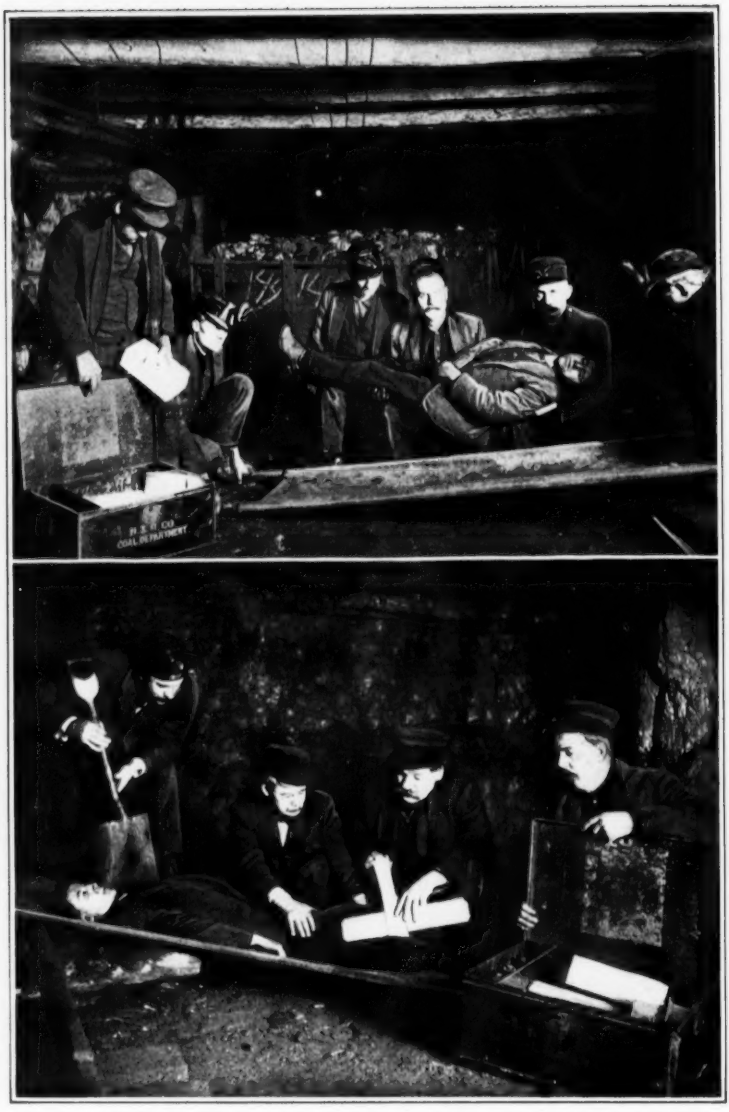
The work has usually started with lectures on physiology, anatomy, and first aid before a selected body of men, and in its subsequent development different degrees of elaborateness are to be found. In some cases a large first-aid society has been developed, including a large number of the men connected with each mine, and having more or less social features connected with it. In other cases there is no distinct organization and first-aid training is considered one of the regular duties of the officials in the operating department. The military aspect is sometimes made prominent in the organization, in other cases this is lacking. Some of the coal companies believe that there is a distinctly educational side to the work which can be made beneficial to the general public as well as to their own employees, and for this reason they arrange for public exhibitions and competitions between first-aid corps from different mines. Some companies restrict these public exhibitions to their own employees, while still others give no publicity whatever to the work and make it strictly a matter of routine and duty.

The pioneer in first-aid work in the anthracite region was Dr. M. J. Shields, now residing in Scranton and having charge of the first-aid work for the coal companies of the Erie Railroad and of the Temple Iron Company. In February, 1900, before he had any official connection with any of the anthracite mining companies, Dr. Shields organized a first-aid society consisting of about 25 men at the Jermyn colliery of the Delaware and Hudson Coal Company. The method there employed is the one now carried out in connection with the coal companies with which Dr. Shields is connected, and is, in general, the method used by the other organizations throughout the anthracite region.

For the general reader it will suffice to say that the men receiving first-aid instruction are divided into squads of usually 5 or 6 each, each squad having its captain, and each squad being provided with a small box containing first-aid appliances such as absorbent cotton, tourniquet, splints, lime-water, aromatic spirits of ammonia, etc.

The general course of instruction for first-aid men includes the following subjects:

1. Shock and its treatment.
2. The treatment of hemorrhage.
3. Fractures and the immediate care of the same. Methods of practical instruction for such cases are illustrated on the next page.
4. Bandaging and the proper application of dressing to be used in case of injury.



FIGS. 5, 6. PRACTICAL INSTRUCTION FOR THE PROPER IMMEDIATE CARE OF FRACTURES.

5. The treatment of burns.
6. Electric shock.
7. Artificial respiration.
8. The handling of patients by one, two, three, or four bearers, either with or without a stretcher, and methods of transferring from a stretcher to an ambulance or a bed. (Figures 5, 6.)

The first-aid men are given to understand distinctly that they are to act only in emergency cases, and in no case are they to attempt to replace a physician or surgeon, who should be summoned as quickly as possible.

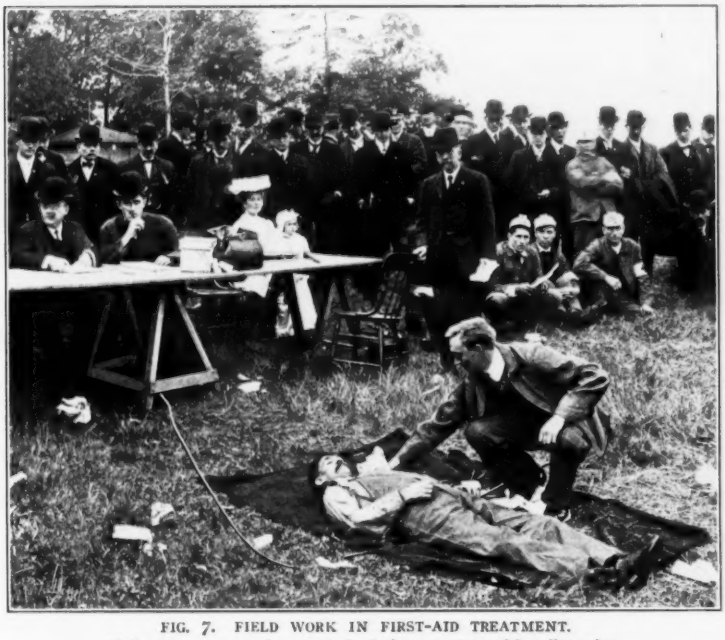


FIG. 7. FIELD WORK IN FIRST-AID TREATMENT.
Relieving a supposed case of shock from contact with a live wire.

One or two of the first-aid men frequently accompany a patient to his destination at his home or the hospital, but they are forbidden to continue in charge of a case after the patient has come under the charge of a surgeon.

The use of alcoholic stimulants by first-aid men is forbidden, excepting under a physician's directions, and if stimulation is needed before the arrival of a physician, black coffee and aromatic spirits of ammonia are prescribed.

FIG. 8. FIELD "EVENTS" IN COMPETITIVE FIRST-AID DRILLS.
Carrying patient in four-hand chair.

Simplicity and the avoidance of all unnecessary technical terms are essential to the success of this work.

As a general rule the anthracite-mining companies divide their mines into districts and sub-districts, a district including several sub-districts and each sub-district including several collieries. In order to arouse and keep up the interest, competitive tests are held by some of the companies between teams in a given district, and there is an annual field day at which the winning teams in each district come together for the final contest. These field days are held in the late summer or early autumn at some pleasure resort, and they have come to be looked upon as one of the yearly features about the mines. The nature of the events, or the "stunts" done by the first-aid corps, will be seen by the following list of events at a contest recently held.

FIRST EVENT: The subject, supposed to be insensible from the effects of gas and thoroughly helpless, was laid on a blanket. One man then picked him up and carried him fifty feet, laid him down and performed artificial respiration for one minute.

SECOND EVENT: The patient was supposed to be insensible from electric shock and was lying over a wire. One man took him off the wire, carried him thirty feet, and performed artificial respiration. (Figure 7.)

THIRD EVENT: The subject was supposed to have a simple fracture of the left leg between the knee and the ankle and to be conscious, and was carried fifty feet by two men forming a four-handed seat. (Figure 8.)

FOURTH EVENT: The subject was supposed to have a simple fracture of the right leg and the other men were to splint the fracture with hay and mine sprags. They then made a temporary stretcher of two coats and two mine drills, placed the man on the stretcher, carried him fifty feet and (Figure 9) took him off the stretcher.

FIFTH EVENT: The subject, supposed to have a wound in the right temple or in the nose, was dressed by one man with the appliances found in a first-aid packet. (Figure 10.)

SIXTH EVENT: The subject was supposed to have a broken leg and a broken arm and to be unconscious. The contestants performed artificial respiration, dressed the wounds so as to stop the hemorrhage, applied temporary splints to the fracture, placed the patient on a stretcher, and carried him fifty feet or more, passing on the way over a loaded mine car over which there was but little head room (Figure 11), a fence (Figure 12), and a pile of rock (Figure 13), and placed the stretcher in an ambulance.

FIG. 9. COMPETITIVE FIRST-AID DRILLS.

Field treatment for fracture, with improvised splints.

Special cups are offered for teams contesting, and members of the winning teams usually receive medals so designed that if a team is successful several succeeding years an additional bar is added to the medal each year to show this fact. (Figure 14.)

FIG. 10. COMPETITIVE DRILL IN BANDAGING FOR VARIOUS INJURIES.

A very realistic event was brought out at the local field day of the Mayfield First Aid Association and afterwards repeated at the general field day of the Erie Companies at Valley View Park on October 3, 1908. This represented a mine accident and rescue by the first-aid

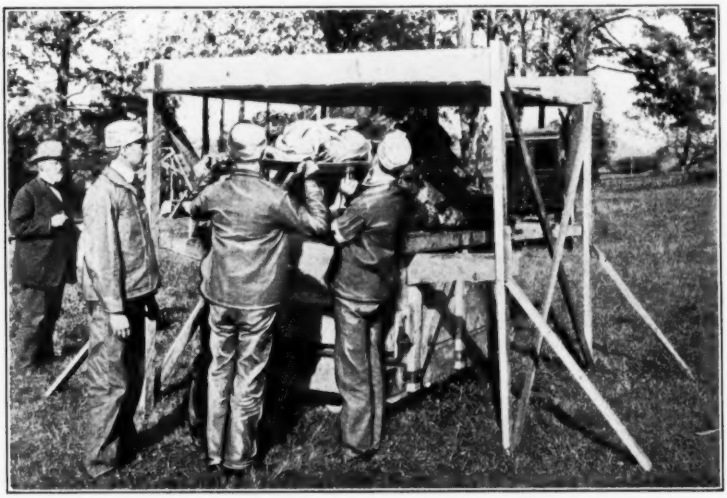
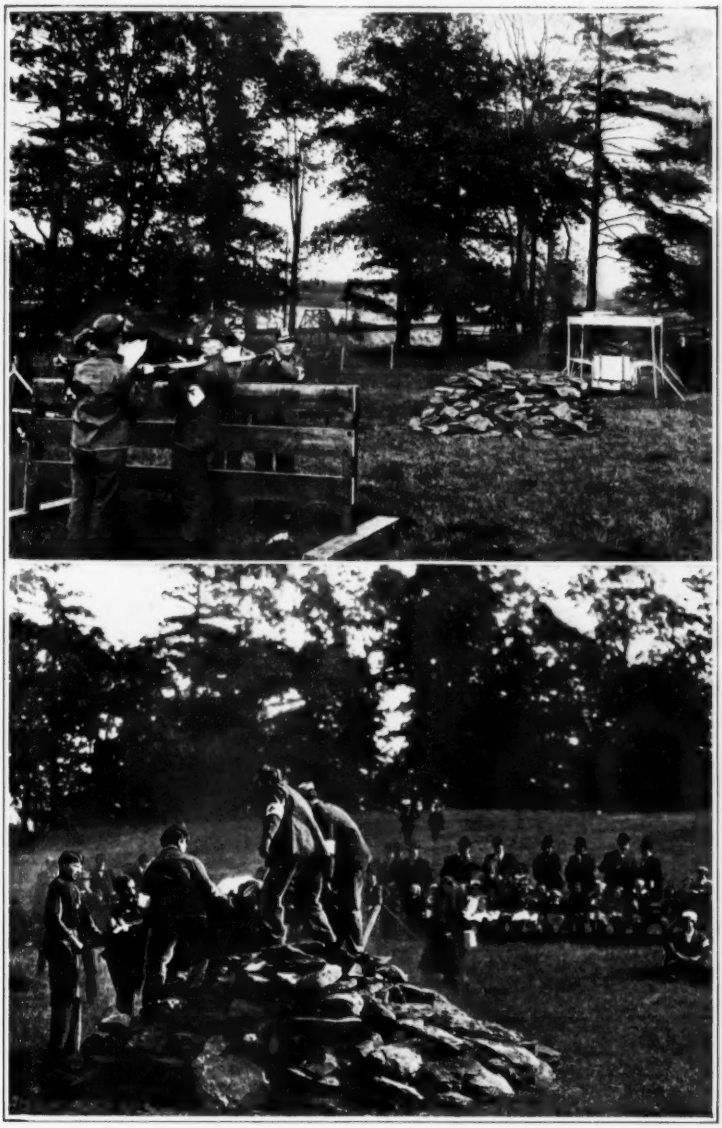


FIG. 11. DRILL IN CARRYING STRETCHER UNDER LIMITED HEAD ROOM.



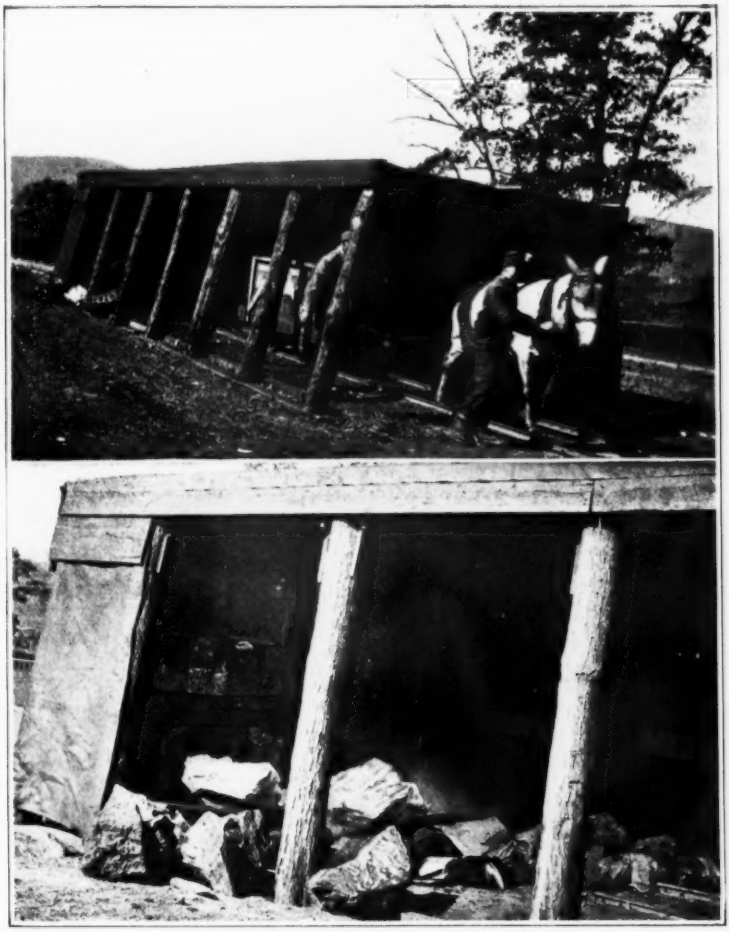
FIGS. 12, 13. DRILL IN CARRYING STRETCHER OVER FENCE AND ROCKS.

FIG 14. MEDAL AWARDED WINNING TEAM IN COMPETITIVE FIRST-AID DRILLS.

corps. A structure had been built (Figures 15 and 16), representing a mine passageway with one side removed so that the interior could be seen. The face was built up with large blocks of coal, a track had been partly laid up to it, and on this was a mine car partly loaded. Back of this was the miner's box in which he keeps his powder and tools. The whole display was very realistic as well as the method of carrying it out. The miner and laborer came to the face and the laborer finished loading the coal while the miner drilled the hole in the face. The driver then brought his mule, hauled out the car, and then the miner loaded the hole, lighted his squib and retired. After the shot had fired the miner made the error which has cost so many lives, for he and the laborer, without especial care, returned to the face immediately to see the result of the shot. As they reached the face, by an ingenious arrangement, the top was made to fall and the miner is shown in the illustration as covered by the falling roof, which in this case consisted of light boards over which bags of hay had been placed. The driver soon appeared and shouted to the miner to know if the car of coal was ready, but getting no answer he repeated the question in the regulation forcible driveresque language. Then getting no reply he went cautiously toward the face, and finding what the trouble was went back and called for help. The first-aid corps arrived, but advanced with care, testing the roof as they went and pulling down loose pieces that were liable to fall. The miner and laborer were then dug out from beneath the fall of roof, taken to a place of safety and first aid rendered, the whole exhibition being exceedingly realistic and well carried out.

The interest taken by the men in these contests is evidenced by the fact that many of the corps now have very trim and tidy white duck costumes with appropriate first aid and red cross insignia upon the sleeves and caps.

Another interesting feature of the field day of the Erie Companies for 1908 was the drill by the boys.



FIGS. 15, 16. REPRESENTATION OF ACCIDENT FROM FALL OF LOOSE ROOF, WITH FOLLOWING RESCUE OF VICTIM.

Especial significance and importance is attached to the 1908 field day of the Erie Companies, as the judges were then for the first time representatives from the Surgeon-General's office of the United States Army, detailed by the Secretary of War for this particular duty.

This recognition of first-aid work by the National Government shows that the War Department realizes that the thousands of mine workers in the anthracite field who have been trained for first-aid

work could render valuable service in the hospital corps of the army, in case of war, as was so done by the St. John's Ambulance Corps, of England, in the Boer War of 1900. The Hillside and the Pennsylvania Coal companies now have about 1,000 trained first-aid men among their 15,000 employes; the Philadelphia & Reading Coal and Iron Co. undoubtedly has several times this number among its 30,000 employes, while most of the other anthracite companies have large and constantly growing bodies of men trained to render first-aid service in case of accident.

The value to any community of men trained to render first aid is, however, fortunately not dependent upon the unlooked for contingency of war, nor even upon the serious accidents that are the necessary accompaniment of every form of mining, for the presence of numbers of such persons in any industrial region is a valuable addition to the working machinery for taking care of the accidents that are unavoidable accompaniments of industry.

In one of the smaller towns of the Schuylkill region of Pennsylvania, upon the occasion of a recent railroad wreck, there was an immediate call for "some of those Philadelphia & Reading first-aid men." At the time of an accident on the Lackawanna road the hospital car from the mines reached the scene of the accident as quickly as the local physician.

At the field competitions many persons see for the first time how to care for the injured properly, and in this way at least a partial knowledge of first aid is taken to many homes throughout the region that would not otherwise be reached. Such field days moreover have a value beyond their first-aid features, for if the men and their families are brought together for social intercourse, they thus tend to create an *esprit de corps* which otherwise is too frequently lacking

These instances are given merely to show that the first-aid movement is far-reaching in its value and is not confined to the mines for which it was primarily intended; it has a wider value. The value of first-aid assistance has been demonstrated beyond peradventure, and any assistance that can be given the movement through official recognition by the State, or even by the National Government, should be given.

METHODS OF THE SANTE FE: EFFICIENCY IN THE MANUFACTURE OF TRANSPORTATION.

By Charles Buxton Going.

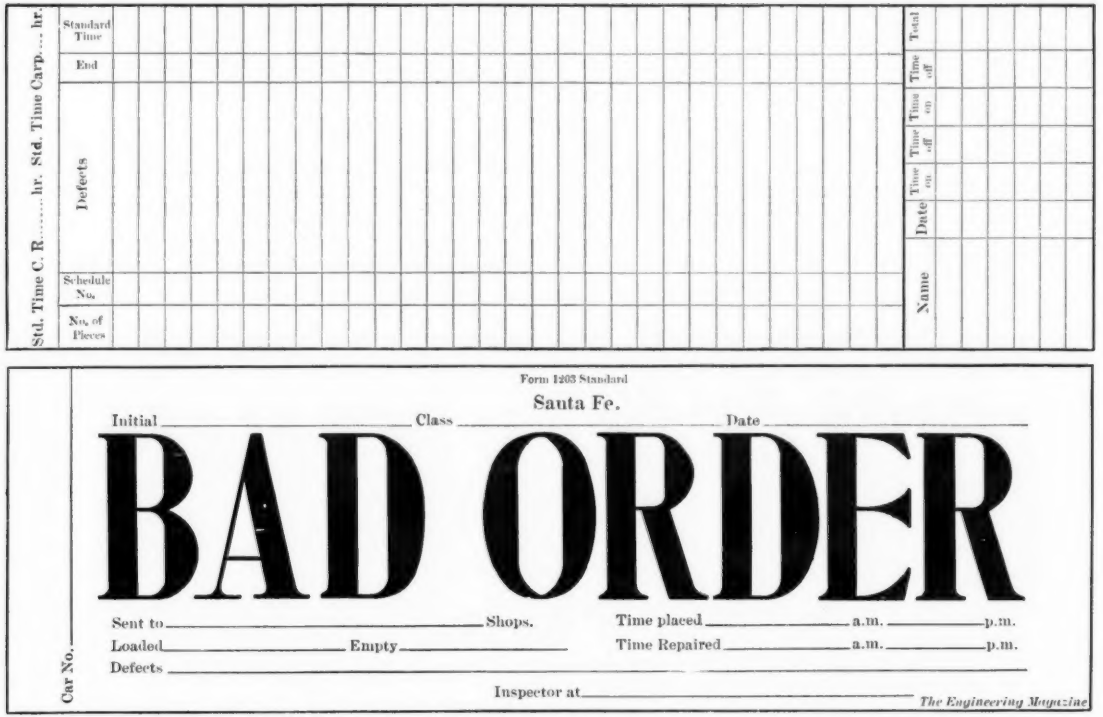
IV. ADMINISTRATION, SUPERVISION AND EXTENSION OF THE BONUS SYSTEM.

The series of which this article is the fourth began in our March issue. Preceding parts have summarized the chief problems of the Santa Fe and their solution, the stores-keeping system in its relations to the mechanical department and the manufacturing organization in the shop, and the general outline of the "efficiency methods." The present installment traces the extension of the bonus plans. A concluding paper in July will cover the apprenticeship system and other characteristic relations with employees.—THE EDITORS.

IN administering the Santa Fe bonus system, the essential purpose is not rigid maintenance of a fixed form under hard crystallized conditions, but continuous adaptation of a living organization to an expanding system. "Administration" and "extension" are therefore practically synonymous terms. The preparation of the 23,000 standard schedules referred to in the preceding article is manifestly a gigantic work, and a work which even when once substantially completed must still be subject to continual readjustment under continually changing conditions. At present, as already stated, the recognition and outlining of operations, and their scheduling with sufficient definiteness for bonus purposes, has covered most of the jobs done in all the shops of the road. The reduction of these schedules to standard form and standard wording, which is the next great step, is making rapid progress coincidently with the use in daily work of the schedules not yet fully standardized.

The May article in this series reviewed the main outline of this work. It remains to consider the executive force by which it is carried on, and the methods by which standardization is reached, first in the definition of the work expressed by the schedule, and second in the time fixed for each schedule at each shop.

These times, it may be well to repeat by way of reminder, are determined by local conditions of equipment, facilities, labor, etc., and may vary considerably as between different shops on identically the same job.



FORM 1203. CARD FOR KEEPING RECORD OF REPAIRS MADE TO CARS AND THE TIME REQUIRED.

Original is a strong card 8¾ by 3¾ in.; face and back are shown. Face is used by yard inspector in "bad-ordering" the car; its position shows switchmen where to place the car—vertically, in the light repair yard, horizontally in heavy repair yard. The main defects listed indicate to the repair-yard foreman how to place the car further. Time of placing is noted; shop inspector removes card, notes all defects on reverse side, and replaces card reverse side out; timekeeper enters standard times scheduled for each repair operation, workmen's names, and actual times taken. Cards then go to bonus office, where records are taken off on record card Form 2202 and are finally filed numerically for permanent reference.

Each of the four grand divisions of the system has its general bonus supervisor, and each large shop has its local supervisor. The determination of the standard times is made under the jurisdiction of the local supervisor. His time schedules are then submitted to the general supervisor for criticism, and comparison with the times fixed for similar operations at other points on the division can thus be made. The figures next go to the master mechanic for approval, and having received this they become as a rule operative, at least tentatively or temporarily. They must, however, be submitted to the mechanical superintendent and to the assistant superintendent of motive power, successively, and they do not become finally and permanently operative until the assistant superintendent of motive power has returned them with his confirmation.

Santa Fe Form 2039 Standard

INDIVIDUAL EFFORT SCHEDULE

..... Schedule No. .....

Machine ..... Standard Cost ..... Standard Time .....

Shop ..... Standard Rate ..... Standard Bonus .....

Checked by ..... Approved by .....
Master Mechanic — Mechanical Superintendent

..... Approved by .....
Bonus Supervisor — Asst. Supt. Motive Power

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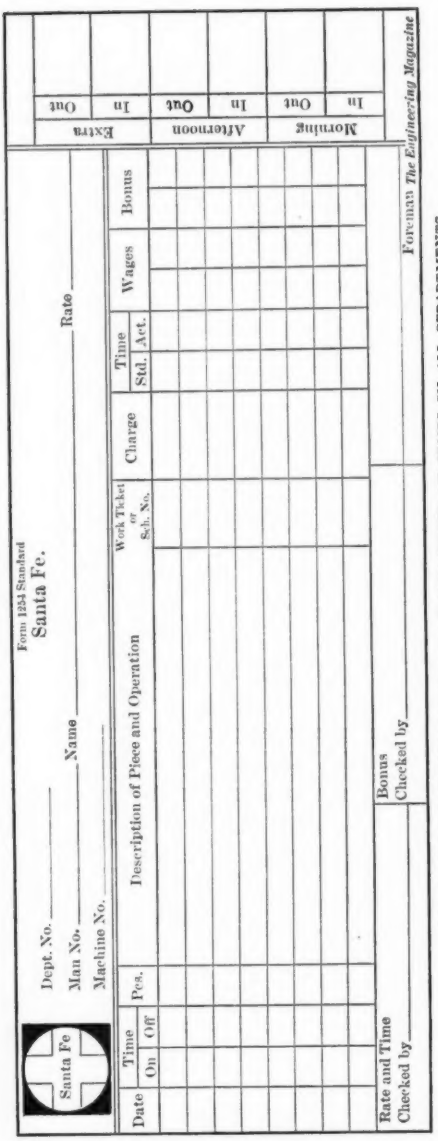
FORM 2039. FORM FOR SUBMISSION OF A NEW SCHEDULE FOR APPROVAL.

A thin sheet 8 by 5 in. Made out after a schedule has been prepared by careful time study; a detailed description of the work is filled in, with the other data indicated, and signed by master mechanic, bonus supervisor, mechanical or shop superintendent, and assistant superintendent of motive power. After final approval, the six copies provided are filed in the offices of superintendent of motive power, assistant superintendent of motive power, mechanical superintendent, motive-power accountant, bonus supervisor and master mechanic.

The local bonus supervisor has charge not only of the initial fixing of standard times, but also of seeing that schedules after adoption are properly applied. He also supervises all general betterment work such as standardizing of tools, introduction of improvements in operations, etc., and in connection with the general foreman


Form 1254 Standard

Santa Fe.

Dept. No. _____

Man No. _____ Name _____ Rate _____

Machine No. _____

Date	Time On	Time Off	Pcs.	Description of Piece and Operation	Work Ticket or Sch. No.	Charge	Time Std.	Time Act.	Wages	Bonus

Form 2202 Standard

BONUS TIME RECORD DEPT. YEAR 19____

NAME _____ NO. _____ RATE _____

MO. _____ MO. _____

Efficiency % _____ Bonus $ _____ Efficiency % _____ Bonus $ _____

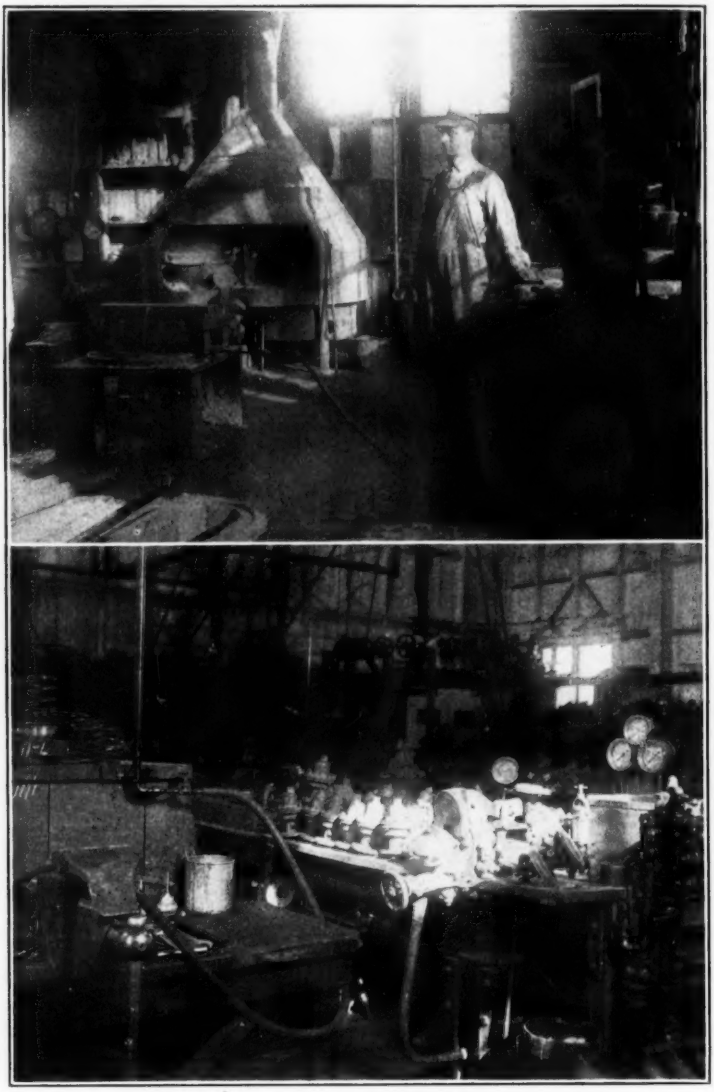
Car No. or Charge	Date	Hours on Bonus		Standard Hours		Defective Work Deduction		Car No. or Charge	Date	Hours on Bonus		Standard Hours		Defective Work Deduction	
Total								Total							

The Engineering Magazine

FORM 2202. INDIVIDUAL BONUS TIME RECORD CARD.

Original is a stiff card 7¼ by 6¼ in., ruled alike on front and back with three entry sections; the reproduction shows but two, on account of page scale. One of these cards is made out for each workman, and is filled with his records for all bonused operations for one month, the records being taken daily from the 1254, 1241 and 1203 cards. At the end of the month the totals of standard and actual times are taken, the efficiency of the man is computed, and bonus paid accordingly. These cards furnish the data for the individual efficiency report and the regular monthly report.

department. The number of timekeepers in any department depends upon the work to be covered, the compactness of the working force, the length of the schedules, etc. One timekeeper may easily check a hundred workmen employed near together on long machine-shop jobs,

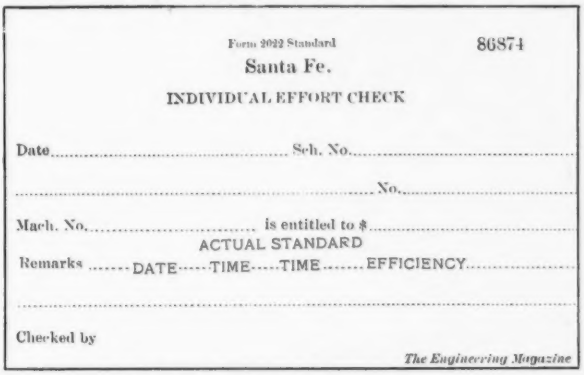


ECONOMY AND SYSTEM IN RAILROAD SHOP OPERATIONS.

In the babbitting plant, above, crossheads are babbitted without planing. Laterals on driving boxes, rocker boxes, and all miscellaneous work is done here by one man at 29 cents an hour. In the air room, below, the triple-valve testing rack is fitted with pneumatic arrangements allowing this class of work to be handled with great rapidity and certainty.

or he may have his hands full keeping track of twenty-five men widely scattered about the place on short schedules. Effort is made to see every man for whom the timekeeper is responsible every thirty minutes, but much of course depends upon the class of work in progress. Timekeepers are chosen wherever possible from helpers or others familiar with the jobs in their departments, the names of parts, etc.

Each operation is recorded on a regular card showing the operation and symbol, the time taken, and the standard time set for the job. This latter is filled in from the standard shop schedule with which the timekeeper is provided. For gang work or pooled schedules, the time record of the leader or gang boss is kept and serves for the others.



Form 2022 Standard 86874

Santa Fe.

INDIVIDUAL EFFORT CHECK

Date..... Sch. No.....

.....No.....

Mach. No..... is entitled to $.....

ACTUAL STANDARD

Remarks .....DATE-----TIME-----TIME.....EFFICIENCY.....

.....

Checked by

The Engineering Magazine

FORM 2022. INDIVIDUAL RECORD OF WORK.

A thin slip 3½ by 2 in., printed in perforated sheets, each slip numbered serially. Issued to the men to keep them informed promptly and accurately of their efficiency and bonus to which they are entitled.

The record of each man as returned to the office daily on the timekeeper's cards is entered by clerks on the individual bonus time record, Form 2202 (page 341). As already explained, the exact time of each separate job is not essential for bonus purposes, the calculation being made on the ratio between the total wage hours actually worked during, say, a month, and the total standard hours of jobs completed during the same period. Jobs unfinished and carried over from one period to another naturally equalize themselves. For accounting purposes, however, the time is distributed by the timekeepers to the various engine or car numbers or accounts.

The extensions of the Santa Fe bonus system which offer the greatest interest are probably those that carry it out of the more familiar field of the shops and into other phases of operation under the mechanical department. In this movement, especially, is the breadth and progressiveness of the Santa Fe policy most apparent—

RACKS BEHIND THE BLACKSMITH SHOP, SAN BERNARDINO.
For methodical storage and arrangement of dies, tongs, and tools of various kinds.

the progressiveness which is in advance even of the best manufacturing practice. Few among the manufacturing plants which have been prominent in the acceptance of the bonus system have shown as much activity, fertility, and ingenuity as the mechanical officials of the Santa Fe in applying the bonus principle to unproductive labor. An outline of these applications to the work of foremen, power-house labor, engine supplies, engine repairs, and road supervision of engines, is not only suggestive of measures valuable for adaptation elsewhere, but is also prophetic of possibilities in other departments of railroad operation which it remains with the future to realize.

FOREMEN'S BONUS.

The wisdom of the Santa Fe bonus system for the promotion of efficiency does not rest merely with provision of a stimulus to the individual worker or the working gang. It realizes that much depends upon enlisting the personal and material interests of the man who is directing the work, as it falls within his power to affect the economy of operation to a very important degree, by the use of discrimination and forethought in the assignment of work and in the avoidance of delays or causes of delay.

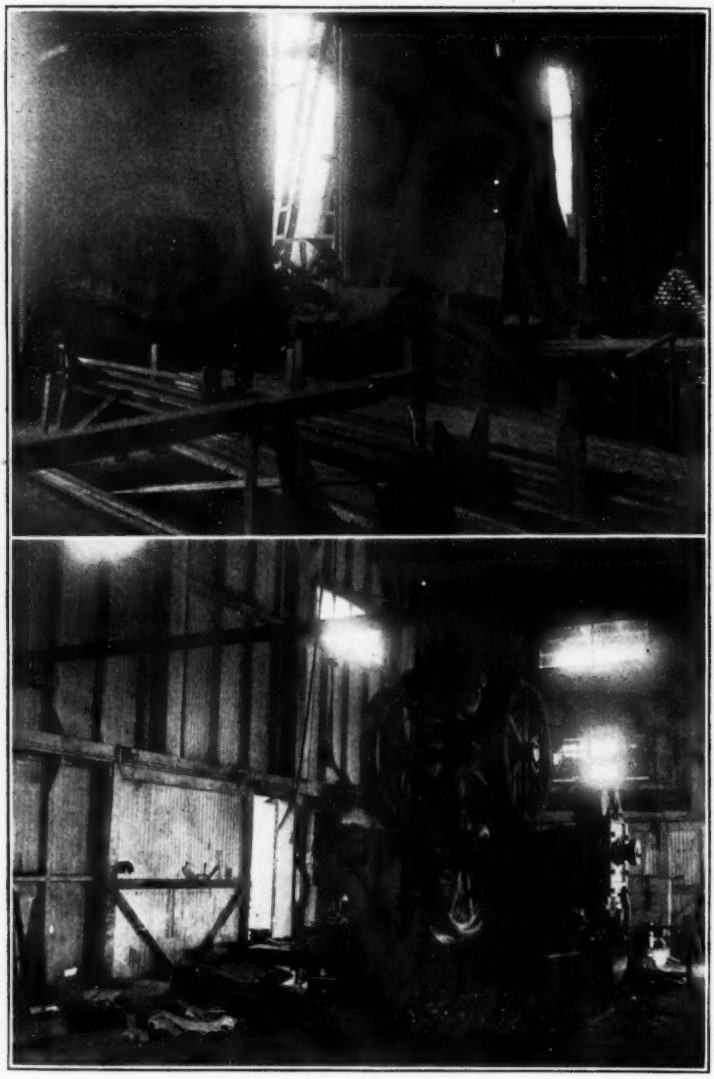
Bonus is therefore paid to foremen at a rate depending upon two principal factors—first, the proportion of all time worked in their

shop that has been brought under bonus schedules, and, second, the average efficiency attained in the performance of all the work under those standard schedules. It is thus equally to the foreman's interest to have bonus schedules applied to all work under his charge, and to have his men better the schedule times after they have been introduced. In short, it is to his personal advantage to work first for the introduction of the system, and then for the results which the system is designed to produce.

The application of the double standard in fixing the foreman's bonus is accomplished as follows: As a preliminary basis, a bonus addition to the foreman's wages is made corresponding to the efficiency shown by the shop as a whole, following in this preliminary addition the regular bonus curve. This bonus, therefore, begins at 66½ per cent efficiency, and at 100 per cent efficiency, as an average for the shop, the bonus added to the foreman's wages would be 20 per cent of those wages, or just the same proportion as would be paid to a workman showing 100 per cent efficiency.

In the case of the foreman, however, this bonus is subject to further modification, depending on the proportion of time worked in his shop under bonus schedules. If 66½ per cent. of all the time on his payrolls is under bonus schedules, his bonus already granted on the ground of average efficiency remains unchanged; if less than 66½ per cent of all the time on his payrolls has been brought under bonus schedules, the bonus granted for average efficiency is reduced; while if more than 66½ per cent of his payroll has been worked under the standard schedules, the bonus granted preliminarily for average efficiency is still further increased. This increase and decrease are on a sliding scale. If only one-third of the work done in the shop has been done on bonus schedules, the deduction is equal to 100 per cent of any bonus which the foreman might have received for high efficiency in the performance of that one-third of the work. If, on the other hand, 100 per cent of the work in the shop has been done on bonus schedules, the foreman receives another 10 per cent of his wages as bonus, in addition to the bonus corresponding to the average efficiency.

For example, suppose the monthly returns for a certain shop show that 80 per cent of the actual hours worked were on bonus schedules, and that the average efficiency of all this scheduled work was 85 per cent. The foreman would receive, first, a bonus addition of 6.17 per cent of his wages, corresponding to 85 per cent efficiency. He would then receive a further addition equal to 1.64 per cent of his wages, corresponding to 80 per cent time worked on bonus, for



SPECIAL FEATURES OF SHOP EQUIPMENT.

The flue welder, above, has a fan installation connected with the fly wheel of the welder, to cool the operator who stands directly in front of the machine. The combination punch and shears below have an up-to-date motor drive, and the machine (which cuts 2½ inch round or square, and punches a 2½-inch hole in 2-inch iron) is tended by Mexican labor at 15 cents an hour.

this account. Suppose, further, as a contrasting case, that in another shop but 43 per cent of the total number of hours worked have been on bonus schedules, but that this scheduled work again shows 85 per cent efficiency. The computation of the foreman's bonus would again assume 6.17 per cent of his wages as the addition corresponding to the 85 per cent efficiency; but the deduction from this due to the small proportion of his shop time brought under bonus schedule (43 per cent) would be 49.55 per cent of the 6.17 per cent first credited, leaving his net bonus only about 3.11 per cent of his wages.

ABSTRACT OF TABLE FOR CALCULATION OF FOREMEN'S BONUS.

Per cent hours or efficiency.	Bonus on per cent hours worked.	Bonus on per cent efficiency.	Per cent deduction.	Per cent hours or efficiency.	Bonus on per cent hours worked.	Bonus on per cent efficiency.	Per cent deduction.
33%	....	....	100.00	70%	.11	.22	.....
34	....	....	92.55	71	.19	.37	.....
35	....	....	88.50	72	.28	.55	.....
36	....	....	83.10	73	.38	.76	.....
37	....	....	77.80	74	.51	1.02	.....
38	....	....	72.65	75	.86	1.31	.....
39	....	....	67.60	76	.82	1.64	.....
40	....	....	62.80	77	1.00	1.98	.....
41	....	....	58.10	78	1.19	2.39	.....
42	....	....	53.70	79	1.40	2.80	.....
43	....	....	49.55	80	1.64	3.27	.....
44	....	....	45.55	81	1.89	3.78	.....
45	....	....	41.60	82	2.17	4.33	.....
46	....	....	37.80	83	2.56	4.92	.....
47	....	....	34.20	84	2.77	5.53	.....
48	....	....	30.85	85	3.09	6.17	.....
49	....	....	27.65	86	3.42	6.84	.....
50	....	....	24.60	87	3.78	7.56	.....
51	....	....	21.65	88	4.16	8.32	.....
52	....	....	18.90	89	4.56	9.11	.....
53	....	....	16.85	90	4.96	9.91	.....
54	....	....	14.00	91	5.37	10.74	.....
55	....	....	11.90	92	5.81	11.62	.....
56	....	....	9.95	93	6.28	12.56	.....
57	....	....	8.20	94	6.76	13.52	.....
58	....	....	6.50	95	7.26	14.52	.....
59	....	....	5.10	96	7.78	15.56	.....
60	....	....	3.80	97	8.31	16.62	.....
61	....	....	2.75	98	8.85	17.70	.....
62	....	....	1.85	99	9.26	18.81	.....
63	....	....	1.10	100	10.00	20.00	.....
64	....	....	.55	101	.....	21.00	.....
65	....	....	.20	102	.....	22.00	.....
66	....	....	.05	103	.....	23.00	.....
66.5	....	....	.....	104	.....	24.00	.....
67	.01	.01	.....	105	.....	25.00	.....
68	.02	.02	.....	106	.....	26.00	.....
69	.06	.11	.....				

The "bonus on hours worked" and "bonus on efficiency" are both expressed in percentages of the foreman's regular wages for the bonus period. The "deduction" made when less than 66.5 per cent of the shop hours are worked on bonus schedules is expressed in percentage of the bonus which otherwise would accrue on account of efficiency—*not* in percentage of wages.

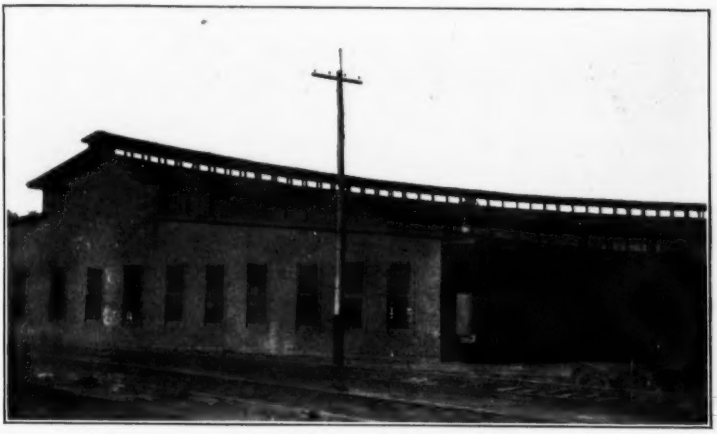
ROAD FOREMEN OF ENGINES.

The bonus award to road foremen of engines is similar in spirit and purpose to that given to foremen of shops. It is designed to enlist careful observation of the condition of efficiency and economy in the supervision and direction of work performed by the rank and file of employees, as well as in the mere performance of separate individual jobs. Furthermore, as shown in the description of the care of motive power, much dependence is placed on the road foreman's report of necessary repairs, and a method connecting the personal advantage of the road foreman with the exercise of the best judgment, and the best economical practice in executing those repairs, can hardly fail to be reflected in improved operating costs to the road.

The bonus to the road foreman is based upon a group of standards. These are: the cost of repairs to freight engines per engine mile; the pounds of fuel for freight engines per 1,000 ton-miles; the miles run per engine failure, both freight and passenger; the cost of lubricants charged to freight engines; the cost of other supplies charged to freight engines; and the average mileage of engines between shoppings, both freight and passenger. These several elements are not all of equal importance in the calculation, the relative values given to them being shown in the subjoined table.

	Relative Values.
Cost of freight-engine repairs per engine-mile, 12 months' average	5
Pounds of fuel, freight engines per 1,000 ton-miles, 12 months' average	5
Miles per failure, freight and passenger engines, 12 months' average	3
Cost of lubricants per 100 engine-miles, 12 months' average	1
Cost of other supplies per 100 engine-miles, 12 months' average	1
Mileage of freight engines between shoppings, 12 months' average	3
Mileage of passenger engines between shoppings, 12 months' average	2

The total efficiency of locomotive performance is determined by averaging the efficiencies under each of the headings above, allowing to these several elements a weight in the average proportionate to its "relative value" factor. Where there is more than one road foreman on a division, the bonus corresponding to the efficiency of locomotive performance on that division is credited to each separately according to his individual wages. The allotment of mileage between shoppings varies as between different divisions of the road, and as between passenger and freight service. On the Los Angeles division, for instance, it is 30,000 miles for freight and 50,000 miles for passenger



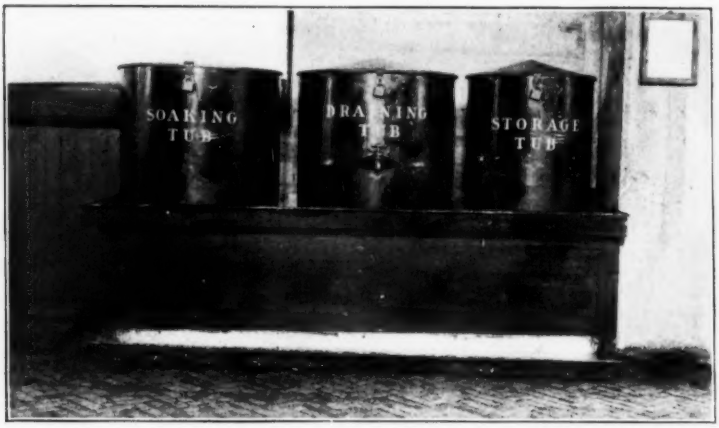
ONE END OF THE NEEDLES ROUND HOUSE.
Showing standards of light and ventilation.

engines, while on the Valley division it is 60,000 miles for freight and 90,000 miles for passenger engines.

The adoption of the multiple standards as a basis serves to provide an excellent balance of interests, to act automatically as a check against the temptation to force the repairs away from a proper measure in either direction. Thus, if repairs are improperly cut down in the effort to make the average per engine-mile small, the inevitable result would be less mileage between shoppings, and the bonus gained on the first account would be cut down on the second. On the other hand, if shopping were postponed longer than expedient so as to increase the mileage, the bad condition of the engine would necessitate heavier running repairs, and so comparison with that standard would become unfavorable.

Master Mechanics' Schedule.

The purpose of extending bonus to master mechanics is to identify them with the efficiency and economy in operation attained on their divisions, and to share with them a proportion of the savings effected by their efforts. In determining how this efficiency shall be measured for the purposes of the schedule, eight bases are adopted, designed to correspond with all the important functional activities a master mechanic may exercise or with all the important accounts in which his watchfulness and ability can be exercised with advantage to the operation of the road. These eight bases are: locomotive repairs per engine mile; freight-car repairs per freight-car mile; passenger-car



WASTE TUBS, SAN BERNARDINO ROUND HOUSE.
A suggestion in cleanliness, order, and safety.

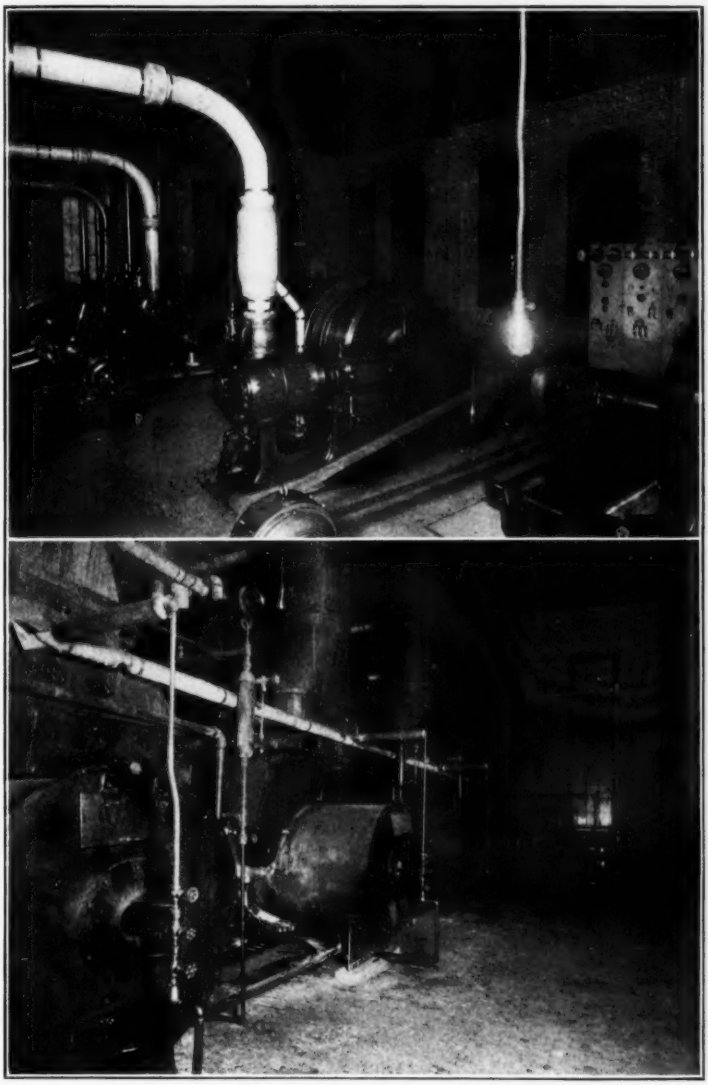
repairs per passenger-car mile; shop tools and machinery per engine mile; engine mileage between shoppings; miles per engine failure; hours of detention by the Mechanical Department per freight engines assigned (minus the time of engines laid up); and total Mechanical Department expenses (freight) per gross ton mile. Efficiency under each of these heads is determined by the ratio of the figures obtained on the division to the allotted cost. But in the final averaging the eight elements are unequally weighted according to the scale of relative values shown below:

	Relative Values.
1—Engine repairs, per engine mile, in cents	5
2—Freight-car repairs, per car mile, in cents	5
3—Passenger-car repairs, per car mile, in cents	4
4—Shop tools and machinery, per engine mile, in cents	1
5—Mileage between shoppings, freight and passenger engines, in miles	3
6—Miles per failure, freight and passenger engines, in miles	1
7—Hours detention, per engine, in hours	3
8—Total mechanical department expense per gross ton-mile, in cents	20

In determining the bonus allowance, the efficiency under each item is calculated from the average performance for the 12 months preceding; these various partial efficiencies are given the relative values shown above. The resultant grand average constitutes the efficiency of the division, and the bonus earnings of the master mechanic are calculated on the division performance.

POWER HOUSE.

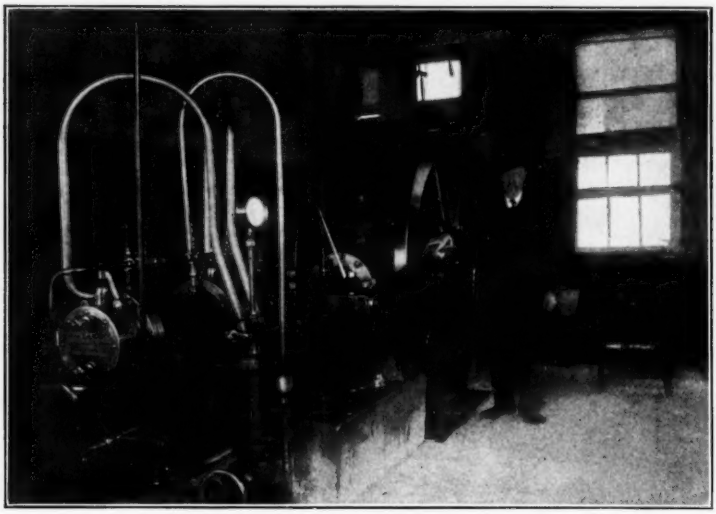
Operating and maintenance costs are carefully investigated, and the averages obtained from a period of time sufficient to equalize all ordinary irregularities are scheduled on the basis of cost per boiler



A MODERN SANTA FE POWER PLANT.

Engine and boiler rooms, Richmond, California.

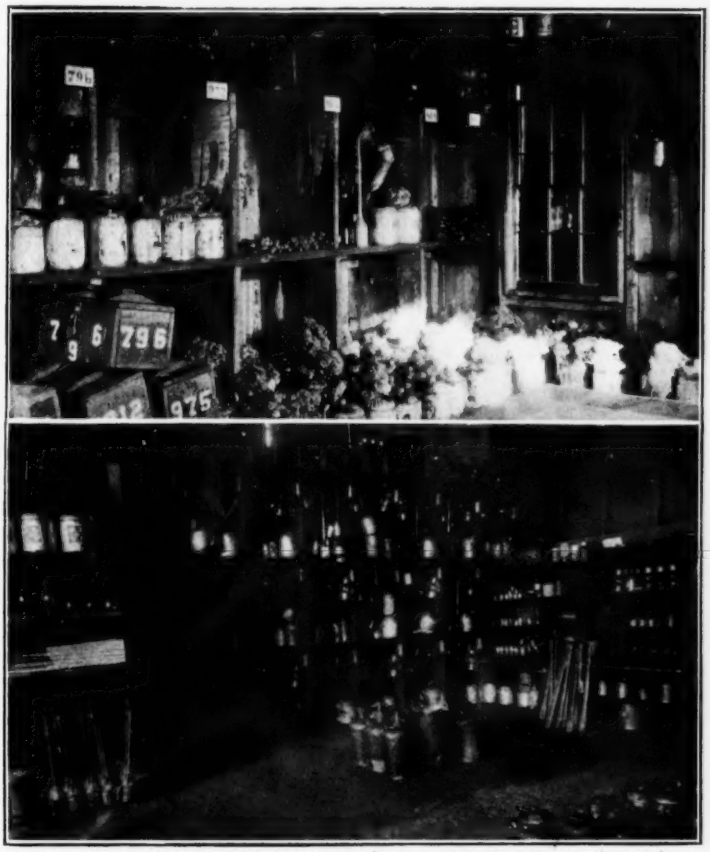
hour. This unit permits of adjustment to any condition of full or partial operation. At the end of the month, the actual results reduced to actual cost per boiler hour are compared with the standard, and the efficiency of operation for the month is determined. In plants burning coal the fuel consumption is determined from the average cost of coal charged to the plant for a period of three months; where oil is used as fuel the fuel cost per boiler hour is obtained from the actual cost of the oil used in the current month. The fuel efficiency of the plant is determined by the ratio between the actual results for a given month and the averaged results established as a standard basis. Bonus, if earned, is determined by the regular efficiency curve as a percentage on the total wages cost, and is divided among all employees of the power plant *pro rata* according to their wages during the same period.



COMPRESSOR, PINTSCH-GAS PLANT, RICHMOND SHOPS.

For charging the gas tanks of gas-lighted Pullmans and coaches. One of the auxiliary industries of a Santa Fe division point.

This figure is further modified by the efficiency shown in the maintenance of machinery as displayed in the accounts for repairs and supplies. A standard allotment is made for this maintenance expenditure; for each dollar of actual cost in excess of the allotment one-half of 1 per cent of any bonus allowed for fuel efficiency is deducted, while for each dollar that the maintenance costs falls below the allotment one-half of 1 per cent of any fuel efficiency bonus is



ENGINE-SUPPLY ROOMS, NEEDLES (ABOVE) AND SAN BERNARDINO (BELOW).

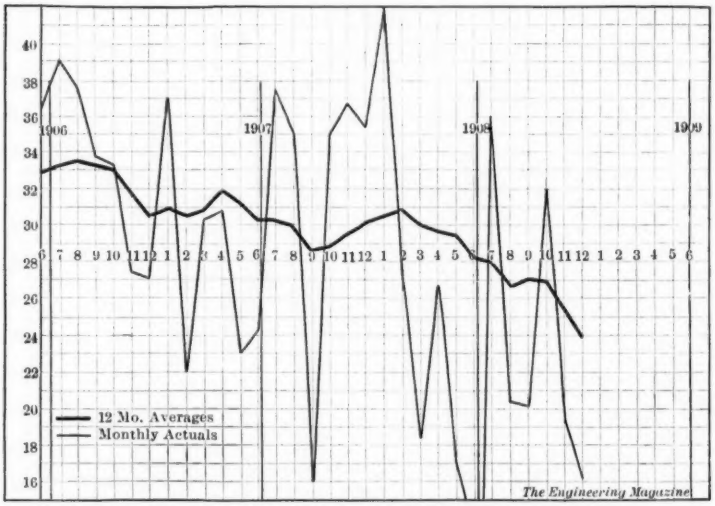
Here the equipment of engines in the shops is systematically stored, overhauled, repaired, and kept until the engines go out again. Over-equipment is removed and held for renewals or replacements.

added. Of these additions or deductions 60 per cent is apportioned to the chief or head engineer and 40 per cent equally among the other engineers.

ENGINE SUPPLIES.

In planning for the extension of the bonus system to the enginemen, the officials of the Mechanical Department of the Santa Fe have sought to develop schedules which would inform engineers and firemen accurately of the conditions and costs involved in the proper maintenance of the mechanical equipment. In other words, the en-

gine schedules refer to questions of materials and expense dependent to a large degree on the enginemen's judgment, and not to questions of actual work performed. In fact, they bonus the engine rather than the man. They bring to the attention of enginemen those elements of upkeep which, unlike their own labor, are not clearly visible to themselves—that is, the dollars and cents expended in equipping, maintaining, and repairing the power; and the bonus devised for any degree of savings in engine supplies or engine repairs is a sort of physical measure of the influence which has been exercised by thus systematically showing these figures of costs, reduced to a time or engine-mile basis.



COST OF SMALL SUPPLIES FOR ENGINES, IN CENTS PER 100 ENGINE-MILES, COAST LINES. JUNE, 1906, TO JANUARY, 1909.

The engine-supply* account is not a large one. On the Coast Lines, for example, where the application of bonus schedules to this account has been most thoroughly studied, the whole amount involved is only $18,000 to $20,000 a year. For this very reason, however, the possible effects of introducing the bonus idea to a class of employees to whom it was unfamiliar, might be examined with special advantage. The problem is a small one, and the results might be demonstrated so that their excellence and enduring justice would become clear to all.

* Engine supplies include all cab fittings, firing and other tools, lanterns and lamps, oil cans, buckets, torches, brooms, engine truck or tank brasses, switch chains, etc. A very interesting feature of the Santa Fe methods is the standardization of this equipment and its systematic handling and upkeep in special storerooms under special custodians.

The initial step was the assumption that a sufficient allowance for small supplies would be one cent for each one dollar in wages paid to the engineer—the engineer's wages being, of course, on a mileage basis, and in a way proportioned to the exactions of the service, and therefore affording a sliding scale closely associated with the necessary use of supplies. On further consideration, this basic allowance was changed to give freight men a more liberal limit of expenditure, and on further thought, still, was extended to include lubrication. Recognition of success in keeping within the allotted allowance is expressed in "merits," and in the plans as first devised this allotment of merits increases progressively, one merit being awarded for the first month in which the engineer's expenditure comes within the allotted allowance, two for the second, and so on until the award reaches five merits per month, success in keeping within the allotted expenditure, however, being determined not simply on the figures for the one month, but upon the average of five months preceding. After the fifth month the award for keeping within the allotment remains constant at five merits per month, the record, however, being averaged back for the entire period until ten months have elapsed, and being taken thereafter from the average of ten months preceding the date of award. If an engineer keeps within one-half the allotment, he would receive double the number of merits above apportioned.

Of the merits thus granted, the first twenty have no cash value. They merely serve, as it were, to run the man up to the point at which cash allowances begin. All merits in excess of the first twenty are worth 15 cents apiece, and conversion into cash is made when a man has accumulated ten convertible merits, or a total of thirty altogether, the account being made up and adjusted every three months. As a further stimulus, the road offers, every three months, three cash prizes of $45, $30, and $15 respectively, to the men making the first, second, and third best records. The example on page 356 shows how the system might work out in a typical case.

In the example given, it will be noted that not until the twelfth month does the average cost per month come down to the allotted cost of $1.50 per month. Then for the first time a credit of 5 merits is received. After this the use of supplies keeps almost continually within the allotment. Twenty merits have been secured by the fifteenth month, but as the first twenty have no cash value no payment is made at that time. By the eighteenth month 40 merits have accrued, and at the quarterly settlement 20 of these are paid for at 15 cents each, making a total of $3.00. The 100 merits granted in the twenty-seventh month, the 200 merits in the thirtieth month, and the 300

EXAMPLE OF VARIABLE RECORD IN ENGINE-SUPPLY BONUS EARNINGS.

Average Wages per Month, $150.00.
Allotted Cost per Month, $1.50.

Month.	Supplies actually drawn.	Total cost (10 mo.).	Average cost per mo.	Merits per mo.	Merits accrued.	Cash.
1	$8.00	$8.00	$8.00	....	....	.....
2	8.00	16.00	8.00	....	....	....
3	.50	16.50	5.30	....	....	.....
4	1.50	18.00	4.50	....	....	.....
5	....	18.00	3.60	....	....	.....
6	....	18.00	3.00	....	....	.....
7	8.60	26.60	3.80	....	....	....
8	.60	27.20	3.40	....	....	.....
9	.70	27.90	3.10	....	....	.....
10	2.10	30.00	3.00	....	....	.....
11	.50	22.50	2.25	....	....	.....
12	.50	15.00	1.50	5	....	.....
				....	5	.....
13	.50	15.00	1.50	5	....	.....
14	1.00	14.50	1.45	5	....	.....
15	.50	15.00	1.50	5	....	.....
				....	20	.....
16	.50	15.50	1.55	0	....	.....
17	.60	7.50	.75	10	....	.....
18	.60	7.50	.75	10	....	.....
				....	40	$3.00
19	.70	7.50	.75	10	....	.....
20	.60	6.00	.60	10	....	.....
21	.50	6.00	.60	10	....	.....
				....	30	1.50
22	.50	6.00	.60	10	....	.....
23	.50	6.00	.60	10	....	.....
24	.50	5.50	.55	10	....	.....
				....	30	1.50
25	.50	5.50	.55	10	....	.....
26	....	5.00	.50	10	....	.....
27	.10	4.30	.45	110	....	.....
				....	130	16.50
28	.60	4.50	.45	10	....	.....
29	.20	4.00	.40	10	....	.....
30	.10	3.50	.35	210	....	.....
				....	230	31.50
31	.50	3.50	.35	10	....	.....
32	....	3.00	.30	10	....	.....
33	.10	2.60	.26	310	....	.....
				....	330	46.50
Total earnings.....						$100.50

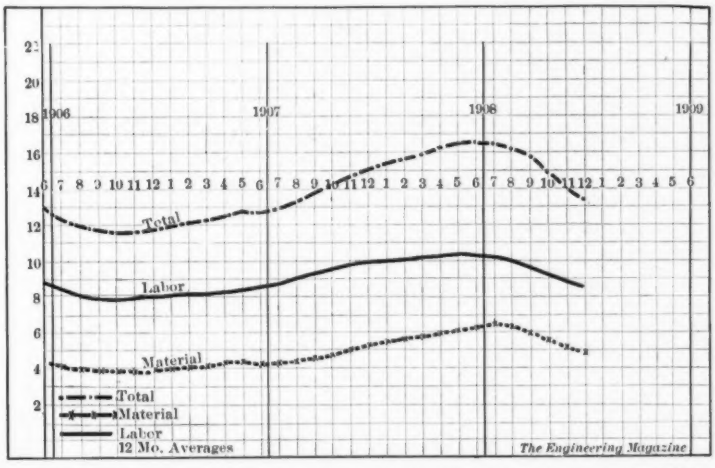
merits in the thirty-third month, represent the awards of third, second and first prizes respectively for attainment of the corresponding records for excellence at these times.

An additional allowance is made for serviceable old equipment not required and returned to stores by the engineer—such equipment as tools, torches, lanterns, etc., found on the engine when it is assigned to the engineer, or found along the line. One merit is allowed for each $1 worth of new value of the material turned in. Locomotive supply-men are also bonused for efficiency and economy.

The results in betterment of operating economy, even in this minor account of engine supplies, are shown by the chart on page 354. At the inauguration of the merit schedule, October, 1906, the average cost of engine supplies for the preceding year was 33 cents per 100 engine miles. For the year ending Dec. 31, 1908, it averaged 23.8 cents per 100 engine miles, the value of all merits earned by engine men included. Between January, 1907, and June, 1908, the cost per engine on the Coast Lines was brought down from $5.50 to $0.86. The highest division in June shows a cost of only $1.61 per engine—less than half the former average—while the lowest division in that month showed a cost of only $0.24 per engine.

ENGINE-REPAIR SCHEDULES.

Beyond the measures already introduced and in practical operation, lies the very important extension of the bonus system which is de-



TOTAL LOCOMOTIVE REPAIRS, IN CENTS PER ENGINE-MILE, COAST LINES, FROM JUNE, 1906, TO JANUARY, 1909.

signed to bring the cost of engine repairs under the same methods, and thereby to secure results advantageous not only to the operation of the road, but to the earnings of employees. The basic study underlying this plan covers the cost of engine repairs, by classes and by districts, for a period of three years past. This includes only light repairs, such as an engine would receive in round house or elsewhere between shoppings. It does not include general repairs, or repairs heavy enough to make an engine lose its mileage. This average cost, reduced to cents per mile for each class of engine and for each district, is considered 66½ per cent efficiency—that is, this fixes the point beyond which bonus is awarded according to the savings made. The efficiency account is kept with the engine—not with individual engineers. As the Santa Fe adopts the system of assigning engines, this is substantially the same thing, but accounting with the engine rather than with the man provides more easily for contingencies and occasional substitutions, and also simplifies the accounting very much.

The efficiency of the engine, as determined by the ratio of actual to standard repair costs, is averaged back month by month up to the first five months, and after that by five-month periods, counting back from the date of computation. Any efficiency gained over the 66½ per cent is recognized by merits awarded according to the regular bonus curve, a merit being one-twentieth of a cent per engine mile. The earnings of the engine are then distributed to the engineer and fireman at the end of the bonus period, according to the mileage each has made with the engine during that period. The scale of apportionment is three-fourths to the engineer and one-fourth to the fireman.

If an engine is transferred to another division, or even another district within the division, its record is closed and begun anew; or if an engine for any reason undergoes repairs sufficient to "lose its mileage," the efficiency account is started afresh. On the other hand, when an engine has been out of the shop for some time and is getting up to 40 per cent or 50 per cent of its allotted mileage between shoppings, the standard allowance for repairs is increased, thus recognizing the condition of the machine and enabling a worn engine to receive its proper and necessary increased repairs without imposing hardship or loss of bonus upon the engineer. It may prove necessary in special cases to recognize conditions arising from defective shop work, but the presumption is that the basing of the standard costs upon observations covering a three-years period will have absorbed and averaged all such influences.

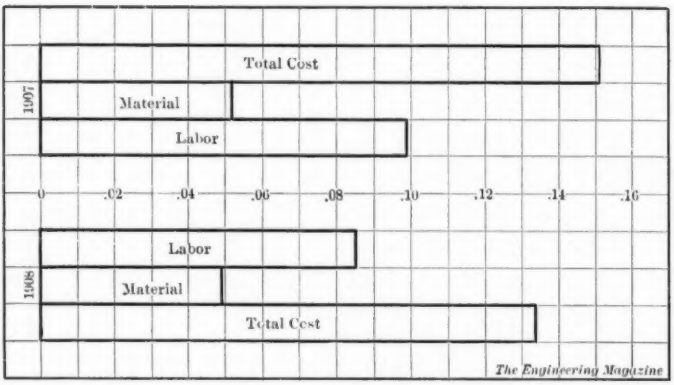
The expectation under which this plan has been framed is that it will bring the engine men into closer touch with engine repairs,

and by their co-operation with the officials, will reduce the repair expense to a minimum and at the same time secure a maximum mileage from the engines. The five-months term over which the efficiency results are averaged before credit is given, is long enough to discourage engineers from allowing their machines to run down in condition and so exhibit a fictitious economy for a transient period.

So far as the engine men are concerned, a complete reciprocal understanding has not yet been established, and the bonus system as above described is not yet in full force and effect. The idea, however, is too large, too sound, and too certainly profitable to both sides, for the ultimate issue to be in doubt. The momentum it has acquired by years of successful demonstration and application not only in the shops of the Santa Fe but in many establishments where it has brought harmony and satisfaction to employees and employers, will unquestionably carry it forward to and beyond the limits of present plans. No doubt there will be modifications of detail. No policy or system yet put forward for the adjustment of relations between men ever found universal acceptance, or ever avoided all difficulties arising from differences in human nature and human judgment. But a movement backed as this is by absolute economic truth is in the end irresistible. Physical opposition, however buttressed, would inevitably go down in the struggle against so powerful a moral force. It might delay, but could not destroy, the fulfilment of the purpose.

Locomotive Inspection.

A further extension of the bonus system covers the inspection of locomotives at repair shops and roundhouses. Although this applies to a relatively small element in the personnel of the Mechanical Department, its importance is proportionately large, as may be seen from the results secured. A stimulus similar to that offered to other employees for improvement in efficiency is here extended to the locomotive inspectors, in recognition of diligence in locating defects that later might cause failures and consequent accidents or delays to trains on the road. In the locomotive shop, the inspector's schedule provides for the preliminary inspection of engines entering the shop, with proper designation of all defective parts. It includes, further, continuous inspection of repair work in progress on the erecting floor, and supervision (in co-operation with foremen) of the workmanship of the shop men. Defective parts or defective work are thus readily found and the defect may be remedied before the locomotive leaves the shop. When the repairs are complete, a second inspection is



TOTAL LOCOMOTIVE REPAIRS, IN CENTS PER ENGINE-MILE, 1907 *vs.* 1908, COAST LINES.

made, and any defects which may have been overlooked are cured before the locomotive is turned over for breaking in. A final inspection is required five hours after the engine has completed the trial trip. Final repairs, if any are necessary, are then effected and the locomotive is turned over for service. Bonus is paid to inspectors for efficiency in locating defects in engines turned out of the shops. The provisions of the schedule insure complete inspection of work and material, the basis of the calculation being as follows:

The inspector is awarded 100 points for each engine turned over for service in satisfactory condition. A credit of 2 points is given for each item of defective work reported by the inspector before the engine goes on its trial trip, and of 1 point for each item reported after this run. For each item reported by the engineer on the trial trip, however, 2 points is deducted from the inspector's award. The efficiency of the inspector is averaged between his own record for success, and the engineer's report of defects, on the whole number of engines turned over.

The schedule for locomotive inspectors in roundhouses is arranged in much the same manner, but an additional item is introduced to stimulate high efficiency in inspection, with a view to reducing the number of preventable engine failures; the bonus paid to roundhouse inspectors is largely governed by the engine-failure statement of locomotives which have passed under their inspection. Even this minor feature, therefore, becomes of large influence in the secure and successful conduct of transportation on the Santa Fe, so far as the functions of the Mechanical Department are involved.

ECONOMIES IN THE MANUFACTURE OF IRON AND STEEL.

By G. B. Waterhouse.

II. THE UTILIZATION OF BLAST-FURNACE SLAG.

In a preceding article Dr. Waterhouse discussed the Gayley dry-blast process as the first of two great economies entering into the modern iron and steel industry to an extent likely to cause important changes in producing costs. In this issue he completes his review for the present by a clear description of the second great factor—the utilization of blast-furnace slag, especially in the manufacture of cement. A third paper taking up yet another important factor—the preliminary treatment of the ores—is being prepared by another contributor. —The Editors.

THE tonnage of slag produced in the iron blast furnaces of the world is very large. In the United States in 1907 there was produced 25,781,360 long tons of pig iron, which is the greatest production in any year. Assuming that for each ton of iron there is produced one and a quarter tons of slag, which is a conservative estimate, the production for 1907 would be the enormous one of 32,226,700 long tons. The disposal of this large amount of waste material is already a question of serious importance, and is one that will unavoidably become greater as the years pass. Of far greater importance, however, is the question of profitably disposing of it, and the following article deals with the different phases of this subject.

Its chief use at present is as filling around the iron and steel plants; or, after being broken to suitable size, as road material. Many plants also granulate the molten slag by means of water, when it is in very suitable shape for ballast for the railroads. The other methods of utilization, in the order of lesser to that of greater importance, are the manufacture of slag blocks, of slag bricks, and of different grades of cement.

Slag Blocks.

With a suitable composition of slag, and under proper conditions as to casting temperature, the kind of the mould, and especially the rate of cooling, blocks can be made that are tough and of excellent wear-resisting quality. They have been made in many countries at various times, and used for different purposes. John Payne, an Englishman, was the first to succeed in making large solid blocks, up

to three tons in weight, which were successfully used in making river and canal embankments. According to his method, patented in 1728, the slag was worked with a shovel to free it from entangled gases and air, and at the same time sand or crushed slag was added. The pasty mass was then pressed into cast-iron moulds, lined with sand. As soon as they were hard the blocks were withdrawn from the mould, and cooled down slowly in a bed of sand and charcoal dust. They were also made at an early date in Sweden, for in 1766 a method was given for their preparation. In 1821, at Bolvig, in Norway, blocks one foot long and six inches wide and high, to the number of 40,000 to 50,000 a year, were made for ordinary buildings. The method was to fill the mould loosely with pieces of slag broken to about walnut size, and then to run in liquid slag. The blocks were removed as soon as possible, and cooled down slowly.

Many attempts have been made to use them for paving blocks. The requirements for this class of material are density, resistance to abrasion, toughness, and a rough surface. By properly varying the character of the mould in which the blocks are cast, and by cooling as slowly as possible, any normal blast-furnace slag can be used, and will give blocks that will fulfill the first three requirements. The chief difficulty is in the slippery surface of a pavement laid with these blocks. One method to produce a rough surface is to use a coarse sand to form the mould; another, and a better one, is to cast the blocks double the size required, and then split them in two along a suitable prepared nick, produced by a projection in the mould. The blocks are then laid with the fractured surface up. The north of England, particularly the Middlesbrough district, has seen the greatest development of this method of utilization.

Slag Bricks.

Several methods have been successfully worked for the manufacture of building bricks from slag. The first were due to the fact that blast-furnace slag, when granulated by being run molten into water, or by having its stream broken up by a stream of water, possesses hydraulic properties. In other words, it is a hydraulic cement, but requires a long time to set. Dr. Lürmann, the well-known German metallurgist, was the first to recognize this, and to utilize it by mixing cream-of-lime with the granulated slag and pressing the mixture into moulds. The lime combined with the free silica in the slag, and, helped by the hydraulic properties of the slag, the bricks hardened by free exposure to the air, in from six to eight weeks.

Considerable attention was paid to this subject in the United States about 1903. The limits for the slag composition were very wide, being:—

Silica	22.5 to 35.0
Alumina and Iron Oxide	16.0 " 21.0
Lime	40.0 " 51.5

The sulphur is harmful and objectionable, and should be kept as low as possible. The slag of suitable composition was granulated, dried, and ground to a fine state of division. Then powdered slaked lime was added to bring the lime percentage to about 55 per cent. The two constituents, after thorough mixing with sufficient water to make a plastic mass, were moulded in a brick press, air dried, and retained for several months, if possible, before marketing.

The bricks varied in color from a grayish white to a dark gray; they were fully equal in strength to ordinary clay bricks, and found a ready sale. Great strides have been made in the manufacture of slag bricks in recent years on the Continent, and many plants are in active operation. There is one also in South Wales at the Landore Works of Messrs. Baldwins, Limited, and their method and the results obtained may be given in some detail. The capacity is from 25,000 to 45,000 bricks a day, 9 inches by 3 inches by 4⅜ inches. There are two buildings, one containing the slag granulator and elevator plant, erected near the blast-furnace plant; the other is larger and is at some distance. It contains a lime-grinding mill with elevator and dust fan, a slag hoist, mixing silo, a preparing or mixing machine, two horizontal brick presses, and three large brick-steaming chambers arranged side by side. A plan of this larger building is shown in Figure I. The plant is steam driven by a 90 horse power horizontal engine, the steam being produced in two Lancashire boilers at 120 pounds per square inch.

The slag used may vary within wide limits. It should, preferably, be of a good grey color. It is granulated by being run into a bosh of water of about six times the volume of the slag. This eliminates a great deal of the free sulphur, and gives a friable product, easy to crush. It is flushed down a culvert that empties itself into a receiving chamber at the bottom of the elevator. It is then elevated and passes through a pair of heavy squeezing rollers which separate the excess of water, and crush any coarse particles of slag. From the rolls it drops into hopper trucks and is removed to stock bins in close proximity to the brick works.

The other constituent of the bricks is burnt lime, containing not more than 0.50 per cent of magnesia. It is put through an ordinary

jaw crusher, in its unslaked condition, and is then ground in a ball mill to about 100 mesh. This ground lime is then filled into measuring bags or boxes, which are arranged according to the percentage of lime to be used in the succeeding mixture. The lime-grinding room is kept free from dust by a small centrifugal fan.

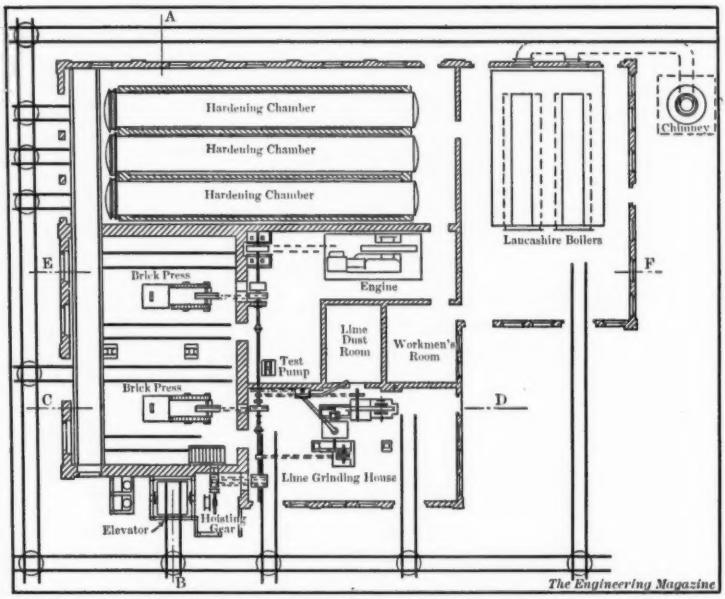


FIG. I. PLANT FOR MANUFACTURE OF SLAG BRICK, LANDORE WORKS, SOUTH WALES.

The slag and unslaked lime are elevated and placed in their proper proportions in a large hopper, at the top of the brick-making building, capable of holding material enough for 1,000 bricks. The proportions are 95 to 93 per cent granulated slag, and 5 to 7 per cent of lime. When full, the hopper is emptied into a steam-jacketed mixer, containing pulverizing blades or paddles, working on the principle of a Green positive-pressure blower. The heat from the steam-jacketed chamber sets up a reaction between the hot lime and the slag. This produces in the material sufficient hardness to enable it to be handled satisfactorily at the brick presses and the hardening chambers. When thoroughly worked, which is perfectly accomplished in from 20 to 25 minutes, the mixture is emptied and fed to the brick presses.

These are so designed that the total pressure is exerted upon the 9 inch by 3 inch face, by the gradual and even approach of two pistons

within a press form. One advantage is that being made in this way, the bricks are always of the same thickness. The bricks from the presses are placed on flat-topped trolleys, each holding from 700 to 900. When loaded the trolleys are taken to the steaming chambers, each of which is capable of holding, when fully charged, about 13,000 bricks. The chamber is then closed, supplied with steam at a pressure of 120 pounds to the square inch, and the bricks allowed to stay for about 12 hours. At the end of this time the steam is blown off as completely as possible into the next chamber, which should by this time be standing ready to receive it.

The bricks are then taken out of the chamber and loaded into trucks. When cold they are ready to be used on any construction. When possible, 5 per cent of lime is mixed with granulated slag in a mill, and used as a mortar for setting the bricks.

The bricks have been used with great success in the several plants of the company, replacing the ordinary quality red bricks in the outer walls of open-hearth furnaces, reheating furnaces, boiler settings, and for general building purposes. They have also been used in the building of several chimney stacks working on hot gases. They have proved to be far more refractory than the ordinary red brick. A noteworthy feature in connection with the plant is a hydraulic testing machine, which enables a careful check to be kept of the product. Typical analyses of the slag, and of the product are given in Table I.

TABLE I. ANALYSES OF SLAG AND BRICK.

		Slag.	Brick.
Lime	CaO	34.71	38.34
Silica	SiO_2	44.03	31.15
Calcium sulphide	CaS	3.69	2.77
Oxide of iron	FeO	.80	.176
Oxide of manganese	MnO	2.16	1.842
Alumina	Al_2O_3	11.40	10.413
Magnesia	MgO	3.10	....
Carbon di-oxide and combined water	CO_2 / HO	.....	13.90

Typical results obtained with these bricks, and ordinary red bricks are given in Table II.

TABLE II. RESULTS OF CRUSHING TESTS.

Material.	Cracked at Lb. per sq. in.	Crushed at
Red brick, wire-cut	250	1200
Red brick, pressed	200	2000
Red brick, pressed	300	1700
Slag brick from steam chambers	2000	2200
Slag brick 9 months old	2000	2200
Slag brick 9 months old	2200	3300
Slag brick 40 months old	2300	2500

The plant employs twenty-three men, three only of whom are skilled, namely, the foreman, the stoker and engineer, and a fitter or blacksmith, and the bricks can be made more cheaply than the red brick with which they will have to compete.

There is another process, the details of which are not at hand, which is said to give excellent results. By it slag is made into bricks without the admixture of lime, cement, or any other binding material. It is based on the fact that silica is rendered ready for combination if exposed to a high steam pressure for a certain length of time.

Cement from Blast-Furnace Slag.

The manufacture of cement from blast-furnace slag is of considerably greater importance than that of either slag blocks or slag bricks, because the cement, weight for weight, sells for a much higher price than either of the other products.

The cements produced may be divided into four classes, which will be taken up in order:

1. The Puzzolan or ordinary slag cement.
2. The true Portland cement.
3. The Eisen-Portland cement, of which a very large quantity is made in Germany.
4. Cements produced by new processes, of which the Colloseus is the most prominent.

The Puzzolan or slag cement takes its name from the Puzzuolana cement. This was the first cement ever made, and was produced from the scoria found at Puzzuoli near Naples. The Romans observed that this scoria, when powdered and mixed with lime and water, would set hard even in water. They used it very largely in their buildings; probably the oldest in which it was employed is the Temple of Castor, erected 496 B. C., and undoubtedly the most famous is the Colosseum, 79 A. D. It was first noted by German chemists that certain blast-furnace slags show a strong similarity in composition to the scoria found at Puzzuoli and neighboring towns, and in 1861 the first artificial Puzzolan was made at the Friederich Wilhelmshütte. The progress of its manufacture was only slow, owing to its limited field of application. Two of the best known names in connection with the early development of the industry are Tetmajer and Prost. Professor Tetmajer examined many slags as to their suitability for making slags, and decided that if the ratio of the lime to the silica was 1.0 or lower, the slag was unsuitable. The lime should be present in a greater ratio. With regard to the alumina, the best results were obtained with a ratio of alumina to silica of from 0.45 to 0.50. If more alumina

than this was present the cement would crack in air. Prost, after many and careful investigations, decided that the hydraulic properties increased as the lime and alumina increased, and he could find no indications of the alumina having harmful properties when present in moderate amounts. He obtained the best results with slags having composition agreeing with the formulae:—

$$2\ SiO_2 \quad Al_2O_3 \quad 3\ CaO, \text{ and } 2\ SiO_2 \quad Al_2O_3 \quad 4\ CaO.$$

In this place it may be well to mention that Mahon made many careful experiments at the Maryland Steel Company, and obtained his best results with slags rich in lime, the compositions being given in Table III.

TABLE III. SLAGS RECOMMENDED BY MAHON.

	1	2
Silica	30.0	25.3
Alumina	17.0	20.1
Lime	47.5	48.0
Magnesia	....	3.28
Sulphur	2.38	2.63

The specifications of the cement department of the Illinois Steel Company were that the slags must be made in a hot furnace, and be light grey. The silica and alumina to be not over 49.0 per cent, the alumina from 13 to 16 per cent, and the magnesia under 4.0 per cent.

There are at present seven plants in the United States making slag cement. They are:

The Struthers Furnace Co.	Struthers, Ohio.
Birmingham Cement Co.	Ensley, Ala.
Southern Cement Co.	Birmingham, Ala.
Ashland Cement Co.	Kentucky.
Stewart Iron Co. (Near Pittsburg)	Sharon, Pa.
One plant at the Brier Hill Co.	Youngstown, Ohio.
One plant at	Sydney, Nova Scotia.

The production is not over 500,000 barrels a year.

The process employed is similar at all the plants, only slag must be used which is of suitable composition, as indicated by the specifications given before. It is thoroughly granulated by means of water, and dried by being heated to a dull red heat in rotary drying kilns. The other constituent is slaked lime. The limestone is burned and thoroughly slaked. This lime is added to the slag in varying amounts, depending upon the composition of the slag. Usually from 25 per cent to 35 per cent is added. The lime and slag are thoroughly mixed, one with the other, in tube mills where the mixture is also ground to the desired fineness. The cement is of low specific gravity, from 2.7

to 2.8; it is slow-setting and is especially fitted for work under water or in tunnels, where it is not directly exposed to the air. Its production has not increased, and in Germany it soon went out of favor. A notable exception on the continent is the plant at Königshofer in Austria, where Puzzolan has been made for fifteen years. It has been used all over Austria and has given such uniformly good results that the Austrian Society of Engineers and Architects has admitted its equality to Portland cement, and allows it to be tested by the same standards. The usual limits of the slag are silica, 24 to 27 per cent; lime, 49 to 54 per cent; alumina, 15 to 19 per cent. From a typical analysis that is given, the ratio of lime to silica is 1.87, and that of alumina to silica 0.60. The slag is, therefore, of exceptionally suitable composition for the manufacture of Puzzolan; 20 per cent of powdered slaked lime is added to the dried and ground granulated slag.

It fulfills all the requirements of a good cement, showing increased strength with age, sufficient binding power when mixed with more sand than 1:3, good adhesion, good wearing quality, and resistance to weathering. Average figures obtained on the cement at different governmental and private testing institutions show, in standard 1:3 mixture, after seven days, 267 pounds per square inch, and after twenty-eight days, 431 pounds per square inch in tension; and in compression, after twenty-eight days, 4092 pounds per square inch. This is an excellent illustration of the fact that with care an excellent product can be obtained.

Portland Cement.

An excellent cement can be made from blast-furnace slag by using it as one of the raw materials in the manufacture of Portland cement, according to the well-known process. This is the process followed by the Universal Cement Company, the subsidiary of the United States Steel Corporation.

This company has two plants, one at Buffington, near Chicago, which takes slag from the Illinois Steel Company at South Chicago; and one at Universal, near Pittsburgh. The former is, in reality, composed of two plants. In 1904 the production of this grade of Portland was 473,294 barrels; in 1905 it was 1,735,343 barrels, and in 1906 it was 2,076,000 barrels The capacity has been increased so that now the plants are capable of making considerably more than 10 per cent of the entire production of the United States. The process has also been followed extensively in Germany but has been replaced by the so called Eisen-Portland.

The process followed is to take thoroughly granulated slag, such as would be suitable for Puzzolan, dry it, and grind it. In some places the iron is then separated magnetically. To it is then added the proper amount of dried and ground limestone to give the required final composition of Portland cement. The mixture is then treated exactly as the marl and limestone in an ordinary cement mill, by being sintered in a long, rotating cylindrical kiln fired with powdered dry coal. The clinker is then stored as long as possible, the action of the air slaking any free lime, and also acting on the clinker so that it is much easier to reduce to powder. Finally it is crushed in a preliminary crusher, and then in tube mills to the desired fineness, only such additions being made as in the case of ordinary Portland to regulate the time of setting. With proper care the raw materials can be kept much more uniform than is the case with natural materials, and a product of excellent quality obtained, that easily meets the standard specifications.

By Eisen-Portland the Germans mean a Portland made according to the above method, to which when ground an addition of finely granulated blast-furnace slag is made. Its specific gravity is intermediate between that of Puzzolan or slag cement, and that of Portland, and averages about 3.0. Opinion is greatly divided as to whether the addition of the slag is a benefit or whether it is simply an adulterant. It developed from the theory promulgated by Dr. Michaelis in 1876, that in hardening Portland cement about one-third of the lime present separates as crystalline calcium hydrate. This has no strengthening effect, and probably a directly harmful one. It follows that if some substance is added that will unite with this free lime, the quantity of effective cement is raised, and calcium hydro-silicate is formed.

The firm of Albrecht Stein & Co., Wetzlar, followed the matter up and made Portland cement from slag and limestone, and with the clinker ground up a certain percentage of dried, granulated blast-furnace slag. For a time this Stein cement met with much opposition, but notwithstanding it increased in popularity, and the method was taken up by other makers. These makers formed an association, known as that of the Eisen-Portland Cement Manufacturers, and agreed that none should mix more than 30 per cent of slag with the clinker. This cement, when set under water, gives as good results as Portland, but in air it sets more slowly. If it can be kept wet for the first few days it gives excellent results.

Ground granulated blast-furnace slag may also, of course, be added to ordinary Portland cement, and in this connection the follow-

ing table of tests is of interest; 25 per cent of granulated slag was added to 75 per cent of Portland, and thoroughly ground together and briquettes made of one part of this mixture to three of sand, and compared with the cement. The tests were made by Dr. H. Seger and E. Cramer of Berlin.

TABLE IV. TENSION AND COMPRESSION.

Lbs. per sq. in.

	Hardened in Air.				Hardened in Water.			
	Tension.		Compression.		Tension.		Compression.	
Time.	Cement.	Mixture.	Cement.	Mixture.	Cement.	Mixture.	Cement.	Mixture.
7 days..	234	292	1321	1401	219	205	1208	1771
30 " ..	356	410	2089	2705	262	271	1553	2046
90 " ..	578	616	2884	4107	335	390	3007	3092

The following results show tests on many grades of the Eisen-Portland, covering many months, and obtained in the usual business way. It should be remembered that the German specifications for Portland cement, at the time these tests were made, were 227 pounds in tension and 2,270 pounds in compression, for the 1:3 mixture after 28 days. The Eisen-Portland was satisfactory in regard to fineness, and the accelerated tests. The strength in tension, after twenty-eight days in air, was 390 pounds; in water, 320 pounds; in compression, hardened in air it was 3,331 pounds, and in water, 3,192 pounds, so that it more than came up to the specifications. These results might be multiplied, but they all go to explain the high degree of favor with which this cement is received on the Continent.

Lastly come the methods of cement making introduced in recent years, of which there are very many; prominent among them is the one based on the patents of Dr. H. Colloseus of Germany, and this is the only one that will be described. This process was introduced about three years ago, and was patented in the United States and Canada in 1906, the patents being owned by the Colloseus Cement Company, of New York. It consists of taking molten basic blast-furnace slag, and granulating it by means of a special granulating device, using solutions of alkaline salts instead of water. The special salts are thus intimately mixed with the slag, and the latter is chemically and physically changed, being in the form of a porous clinker easily crushed and powdered. It is in operation at four plants in Germany, one in Scotland, where very extensive and careful trials were made, and in America there are two plants, one at Hamilton, Ont., the other at Buffalo, N. Y., the latter of which is producing cement on a commercial scale. The chief salt used in preparing the

solution is magnesium sulphate—crude Epsom salts — and the concentration for general work is 5 per cent. The stream of molten slag falls on to a horizontal ribbed cast-iron drum, shown in section and elevation in Figures 2 and 3. This is rotated at 650 revolutions per minute. Between the ribs are slots through which sprays the granulating solution. In addition, a jet of solution is projected on the drum just below the stream of slag. The slag is granulated and forms little pellets. It is projected with great force on to the water-jacketed casing and falls down either into a buggy, or preferably onto a turn table. The latter affords an opportunity of separating any ungranulated slag that may fall from the spout.

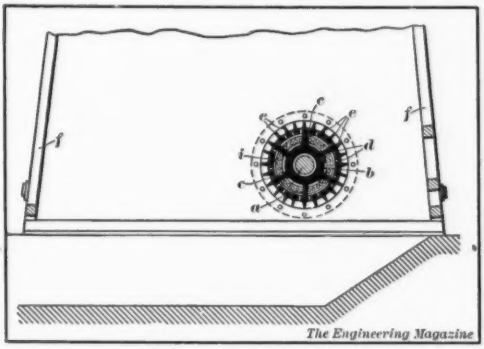


FIG. 2. SECTION OF COLLOSEUS SLAG-GRANULATING DRUM.

So much solution only is used that the granulated slag is perfectly dry after the operation. The clinker is then treated as in the case of ordinary cement clinker, only such additions being made as is customary, to regulate the setting.

The slags may vary widely in composition, as is evidenced by the following table showing examples of those used at five different plants and giving their analyses in silica, alumina, and lime. The sulphur should be low, and the magnesia below 3.50 to 4.0 per cent.

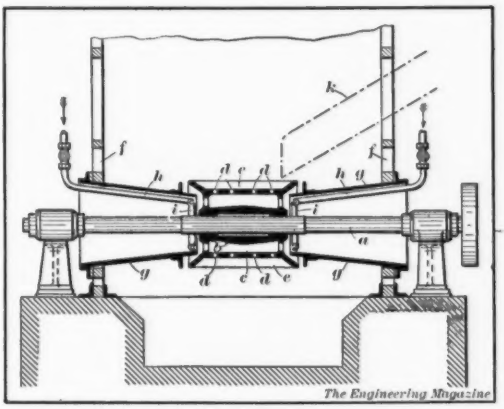


FIG. 3. ELEVATION OF COLLOSEUS SLAG-GRANULATING DRUM.

TABLE V. SLAGS USED IN THE COLLOSEUS PROCESS.

	Buffalo.	Porz.	Duisburg.	Harzburg.	Scotland.
Silica	35.05	27.73	35.02	27.56	28.57
Alumina	12.46	12.85	11.08	19.25	17.15
Lime	45.74	52.89	48.86	45.11	46.32

The cement has given excellent results, and it is evident it can be kept remarkably uniform in composition and properties. Some results may be given, obtained on properly identified samples at the famous cement-testing laboratory of Dr. Michaelis in Germany. The specific gravity was 2.97. It showed preliminary set in 19 minutes and final set in 36 minutes. Another sample gave 18 and 43 minutes respectively after four-weeks' storage. This shows that Dr. Colloseus has produced a cement that will set quickly, and has overcome the slow-setting quality of granulated slag, which is itself a very slow-setting hydraulic cement. The fineness was very good, as also the constancy of volume. The results of tension were as follows on the fresh cement, and on cement stored for a month; both in the neat state and in the 1.3 mixture.

TABLE VI. RESULTS ON COLLOSEUS CEMENT.

Each figure average of ten briquettes.

	Hardened in Water.		Hardened in Air.	
Neat Cement.	Fresh.	Stored.	Fresh.	Stored.
3 days.....	483	508	476	445
7 days.....	536	560	619	581
28 days.....	543	593	743	708
1 : 3 Mixture.				
3 days.....	233	236	267	253
7 days.....	274	309	345	316
28 days.....	285	343	368	389

In several respects this cement possesses qualities that render it superior to standard Portland. It contains absolutely no free lime, and is, therefore, free from expansion; and being made from a completely fused material, and has greater fire-resisting qualities. It is also not affected by sea water as is ordinary Portland, and is stainless. It appears to have before it a big future, and will help to bring about the prophecy of a Government official that in a very few years all cement would be made from blast-furnace slag as a raw material.

TEMPERATURE DETERMINATION AND CONTROL FOR HIGH-SPEED STEEL TREATMENT.

By O. M. Becker.

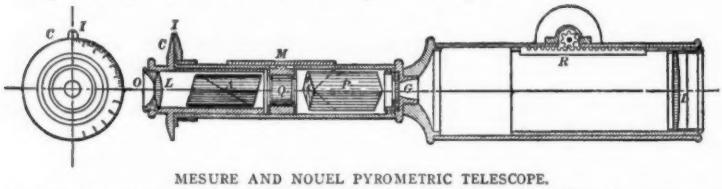
In a preceding article, Mr. Becker has shown the importance of accurate temperature determination and duplication in high-speed steel treatment, and has reviewed pyrometric devices designed for direct exposure to the heat to be gauged. In the following pages, he discusses the principles and uses of pyrometers of the optical and radiation types, the choice and installation of temperature-measuring apparatus, and the importance of recording devices in connection with their use.—THE EDITORS.

THE deterioration of the fire ends is the weak point in most pyrometers of the direct-exposure type; and to obviate the difficulty instruments have been devised which do not require to have any part directly exposed to the high temperature sought to be gauged. These, with one exception, are of the optical type; and all utilize the energy of radiant matter transmitted to any convenient distance, in the determination of the temperature of the body under observation.

Of all the pyrometers adapted to use in hardening operations, the Mesure and Nouel is perhaps the simplest, since it is entirely self-contained and has no delicate parts to get out of order. It utilizes the colored field produced by the polarization of light from the object observed, and the accuracy of a temperature reading or of its maintenance depends upon the judgment of relative colors, very much as when the natural colors of a heated object are viewed by the unaided eye. For this reason, among others, it is of material assistance only in the hands of a skilled operator, and even such an one cannot be sure of any accuracy within 50 degrees C. or more at temperatures above 1,000 degrees C.

The Le Chatelier and the Wanner optical and the Féry absorption pyrometers all depend upon a photometric comparison of the relative brightness of the two halves of the illuminated field, one half receiving its light from the radiant object, the other half from a standard source of light forming part of the instrument. The Le Chatelier instrument utilizes an iris diaphragm for regulating the amount of light admitted from the radiant object, in combination with a mirror and a standard source of light of known intensity, the light from the two sources each covering half the field. By adjusting the diaphragm until the two halves are of equal brightness, the temperatures can be read, or calculated, from the scale attached to the diaphragm.

Féry uses a system of absorbent wedges for the same purpose, and the reading is taken in the same way. The Wanner instrument utilizes, in combination with the standard source of light, a system of prisms and lenses for polarizing in such a way that by turning the analyzer with its attached graduated scale, the two halves of the illuminated field, one receiving light from the standard of comparison and the other from the object observed, may be made of the same luminosity and the temperature then read off at the scale. All the above pyrometers, except the Mesure and Nouel, are quite accurate in the determination of relative temperatures within their several ranges. Generally speaking, the probable error is less than one per cent, and in some cases only half as great.



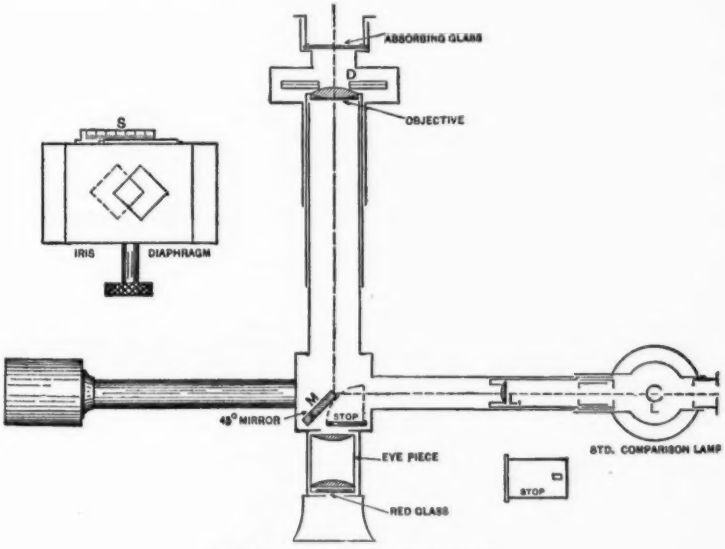
MESURE AND NOUEL PYROMETRIC TELESCOPE.

G, ground diffusing glass; *P*, polarizing Nicol; *Q*, quartz plate; *A*, analyzer; *OL*, eyepiece; *R*, rack and pinion; *C*, graduated circle, calibrated and reduced to temperature scale; *L*, objective.

Perhaps the most convenient of the optical pyrometers which are accurate enough for use in connection with high-speed steel treatment, is the Morse thermo-gauge, made in Europe with some slight modification under the name Holborn-Kurlbaum pyrometer. It consists of a tube, furnished with lenses if desired, within which is the filament of a small low-voltage electric lamp. In the lamp circuit is a rheostat and a milli-ammeter. The radiant substance whose temperature is to be determined is observed through the tube, and the current passing through the filament is at the same time so regulated through the rheostat that the filament disappears against the bright surface under observation. The current used is indicated by the milli-ammeter, and this can be reduced to terms of temperature; or, most usually, the temperature is read directly from the scale. With very little practice the eye becomes very sensitive to any difference between the brightness of the filament and that of the object upon which it is superposed, and temperatures can without difficulty be read with a probable error not exceeding two or three degrees C. With this instrument it is possible to prearrange the conditions for the required temperature, to know with certainty when it is reached, and to reproduce the same indefinitely. For the higher temperatures, say above 800 degrees C., absorbent glasses are pro-

vided for reducing the dazzling brilliancy of the field. With these accessories the highest temperatures can be read very accurately.

The Féry radiation pyrometer combines some of the features of the optical instruments with a delicate thermo-couple in the circuit with a sensitive potential galvanometer whose indications may be read in degrees of temperature. It is virtually a reflecting telescope, the concave mirror focusing the radiant heat of the object under observation, upon the "hot" junction of the tiny thermo-couple. The instrument is sighted upon the object and focused by a rack and pinion at the side. There is also a diaphragm for reducing the effective aperture when the instrument is pointed at a very hot object preventing the overheating of the thermo-couple.

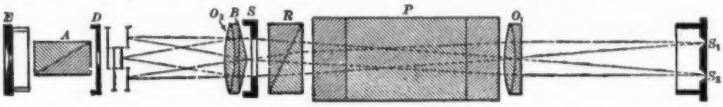


LE CHATELIER OPTICAL PYROMETER.

Chas. Engelhard, N. Y.

Optical and radiation pyrometers are entirely separate from, and within limits may be at any required distance from, the source of the heat to be gauged; so that they are not at all affected by even the highest temperatures obtainable. Their permanence, therefore, and their reliability are very great, as compared with most other forms. The distance, as is well known, does of course affect the energy of radiated heat and light waves; but within the limits usually imposed in the kind of work now under consideration, the loss

is quite inappreciable. Thus it has been shown with a Féry radiation pyrometer that the temperature indication of a stream of molten steel was precisely the same at a distance of three or sixty feet.

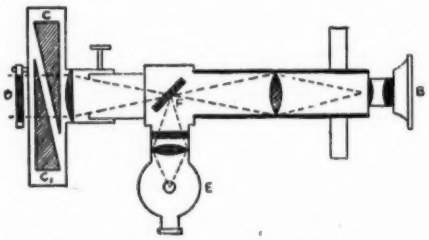


WANNER OPTICAL PYROMETER.

A, Nicol analyzer; *B*, biprism for eliminating images; *D*, slit through which images are observed by analyzer; *E*, eyepiece; O_2, lens for focusing image upon *D*; O_1, objective; *P*, *d-v* prism; *R*, Rochon prism; S_1 slit for admission of light from standard; S_2, slit for admission of light from object observed. Eimer & Amend, N. Y.

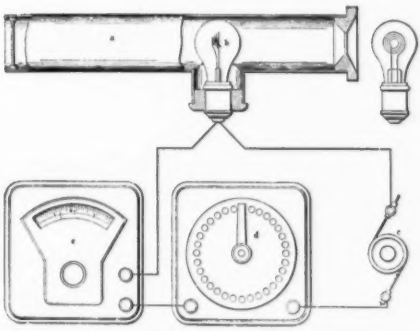
The comparison light or filament, as the case may be, where such is required, naturally deteriorates somewhat with long use; but even then the falling off in accuracy is surprisingly small. It is of course desirable that these, like all other pyrometers, be compared with standards from time to time and kept properly calibrated.

It must be remembered, in using pyrometers of this class, that not all bodies radiate the same amount of energy at similar temperatures, and that there are certain definite conditions under which the indications will be correct for the object observed. For the present purpose it is perhaps sufficient to point out that an instrument calibrated for use in gauging the temperature of a furnace interior is not adapted, without re-calibration, or at any rate without taking into account this special factor, for use in investigating the temperature of a tool in the open air. The instrument must be calibrated for the intended use. Not only this, but it is necessary to take into account that these instruments are based upon the laws of radiation from a so-called "black body," whether those radiations have a long (heat) or a short (light) wave length; and that unless specially calibrated they will give correct readings only when the object under observation approximates, in its conditions, a "black body"—that is, has its reflecting power reduced to a negligible minimum. This is accomplished nearly enough, in high-speed steel treatment, by observing the tools as they lie within a furnace the temperature of



FÉRY MIRROR OR ABSORPTION PYROMETER.

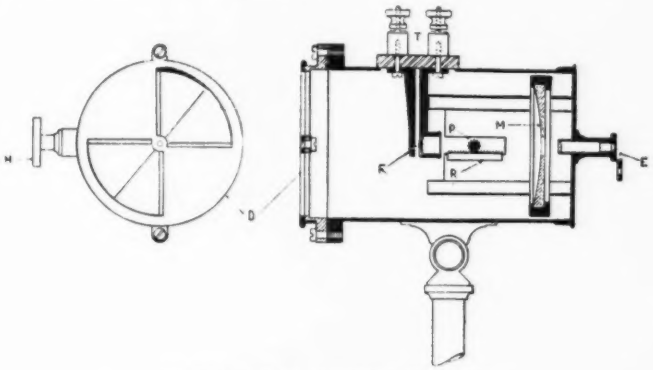
DB, small telescope with eyepiece B; E, standard lamp; F, mirror; CC_1, absorbing wedges. Taylor Instrument Co., Rochester.



MORSE THERMO-GAUGE.

a, sighting tube or telescope; b, incandescent lamp; c, generator; d, rheostat for controlling temperature of filament; e, indicator. Morse Thermo-Gauge Co., Trumansburg, N. Y.

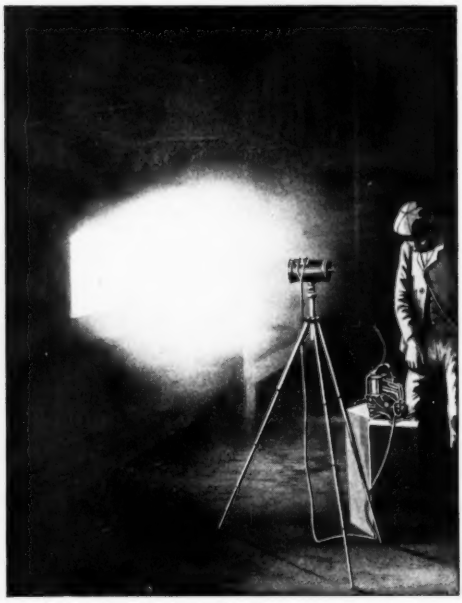
whose fire clay walls is the same as that of the tool, the observation being carried on through a very small opening in the furnace walls. Under these conditions the contents of the furnace no longer are seen as having separate form, their radiation being practically the same as that from the heated walls; and in practice therefore it is necessary only to sight the pyrometer into the furnace—remembering that the conditions are not well fulfilled unless the opening through which the temperature is to be gauged is relatively small. It is customary, in order to fulfil the conditions still more closely, to insert into the furnace a porcelain or iron tube of considerable length compared with its diameter, and to sight the instrument into the tube.



SECTION OF FÉRY RADIATION PYROMETER.

E, eyepiece; F, thermo-couple; M, concave mirror with aperture; HPR, rack and pinion for focusing; D, diaphragm; T, binding posts. Taylor Instrument Co., agents for Cambridge Scientific Instrument Co., Ltd.

The responsiveness and the power of discrimination of the Morse and Féry pyrometers especially are remarkable, though ability to determine minute changes of course depends considerably upon the personality of the observer. Ordinarily, at the higher temperatures,



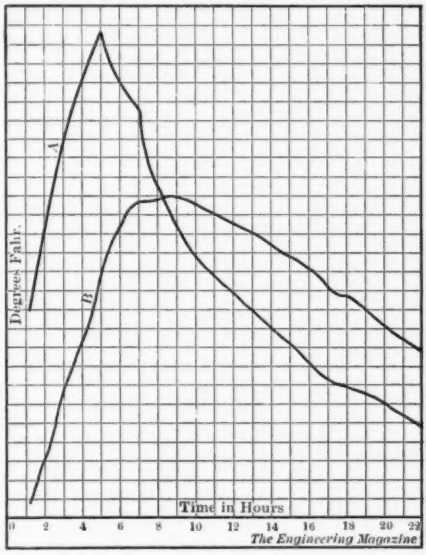
FÉRY RADIATION PYROMETER IN USE.
Taylor Instrument Co., Rochester.

a variation of no more than 5 degrees C. can be very easily detected. The power of discrimination therefore is considerably finer than the absolute accuracy, which latter depends in part upon factors frequently neglected, and as already indicated, may vary from one to three per cent at those temperatures. This, however, is a matter of comparatively small moment in the hardening of tools, since absolute temperatures are more or less empirical anyway. Obviously the required temperatures will vary, to some extent, with the kind of steel used, and also with the operator and his pyrometer, whether that be of the optical or of some other class. The important thing is that the temperature gauge shall be consistent with itself, and that data shall be recorded which will make it possible to reproduce with precision the temperature conditions found experimentally to yield the highest efficiency in the particular tools treated.

It must be borne in mind that, in so far as the methods of pyrometry here described are used in connection with high-speed steel treatment (or the treatment of other tools, for the matter of that) the temperatures observed or recorded are those of the atmosphere or bath surrounding the tools, and not necessarily those of the tools themselves. Optical and radiation pyrometers of course can be sighted directly upon the tools, when contained in a furnace; and "poker" pyrometers are to be had with exposed fire ends drawn to fine points which may be placed against the surface of the tool under observation and its surface temperature in that way be measured directly. Such methods however, are not necessary, and usually are not employed in tool making. Anyway, the interior temperature of

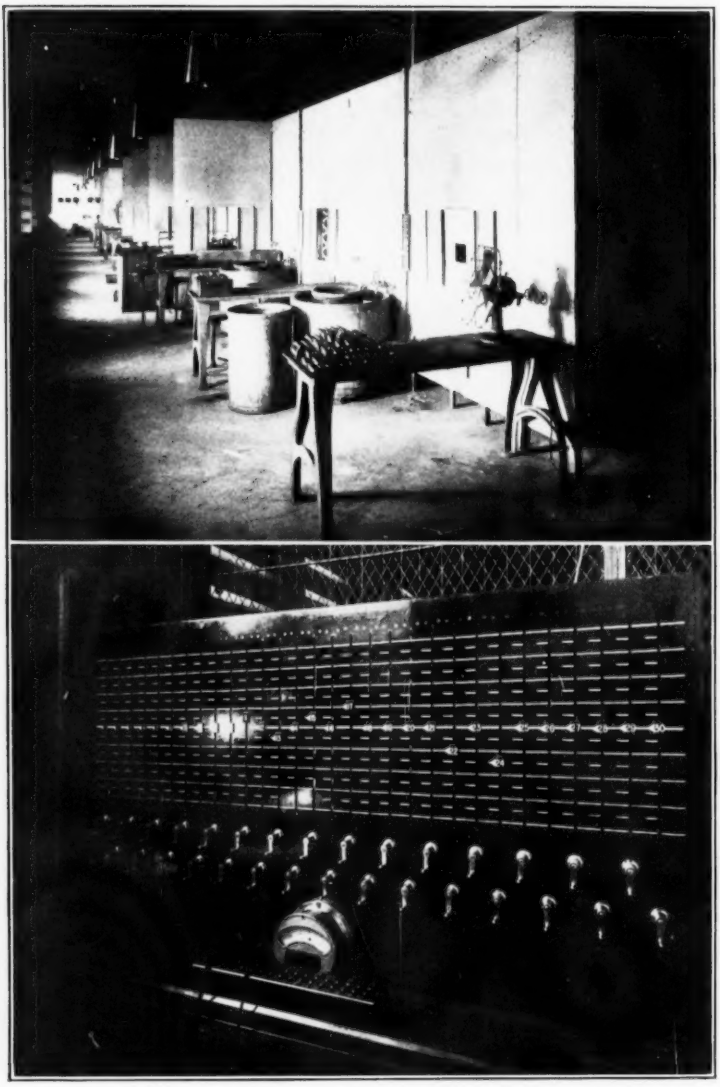
a tool could not be determined in any such manner, for the surface and the interior heat conditions could easily be very different. It is sufficient to remember that time must be given for the tool to acquire throughout its mass (or that part to be heated, at any rate) very nearly the temperature of the furnace or bath. The larger the tool, of course, the greater the lag. This is particularly important in annealing tools packed in boxes and the like, in which case the lag may easily be sufficient to prevent proper annealing, even after a long heat. The safest procedure when such work is undertaken is to make provision for inserting a pyrometer "poker" into the annealing box. A pipe well, such as has been mentioned before, is easily arranged and answers the purpose. This would, of course, be so placed relatively to some convenient opening, as to permit inserting the "poker" with little trouble or discomfort.

The kind of temperature gauge adopted in a hardening plant will naturally be largely a matter of personal choice in the management and the permissible cost, as well as the particular work required. Where the cost of the installation is not closely limited it will usually be desirable to have at least two different types of pyrometer—say an optical or radiation, and a thermo-couple; this not only in order that one may be used as a check upon the other, but because of the greater convenience of one or the other for certain kinds of work. The optical instrument, for example, has been already said to be unsuited for gauging the temperature of the barium bath, unless especially calibrated for that purpose. None of this class of instruments, it seems, has yet been provided with an indicator capable of being used at a



CURVES SHOWING LAG OF POT TEMPERATURES.

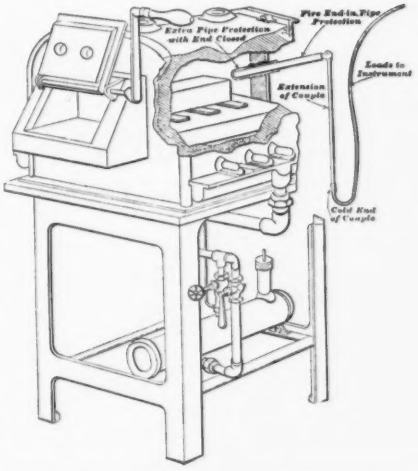
A, temperature curve of fire space of furnace; B, temperature curve of center of pot containing material to be annealed. Taken with Bristol electric pyrometer couples.



PYROMETER INDICATOR, SWITCHBOARD AND INDICATOR BOARD SHOWING REQUIRED TEMPERATURE AT EACH FURNACE AND TEMPERATURE FOUND.

The switchboard is shown below. Turning the proper crank cuts in the desired pyrometer and sets the pointer at any furnace front to correspond with that at the board. The indicator at the furnace is shown in the upper view. The apparatus is that devised and used by the Standard Tool Co., Cleveland.

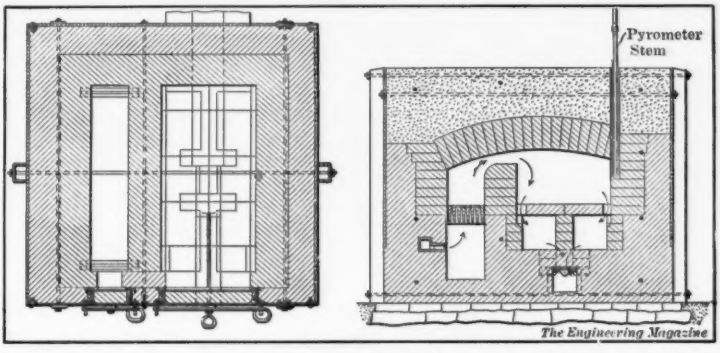
distance and automatic in its action. Such an arrangement frequently is very desirable; and where the plant is large, the indicator and switchboard is an important feature of the equipment, permitting the supervisor of this work to be informed at will of the condition of any or all furnaces in operation. This is easily possible with the electrical pyrometers. Each furnace can be fitted at small expense with a "poker" capable of being switched into the indicator circuit at will, or connected with its own indicator or recorder, as the case may be. In some instances it is desirable that the instrument be in a circuit with an indicator for use by the operator, and a recorder in the office for the use of the supervisor and for furnishing permanent records for future reference.


Fire End in Fire Protection
Extra Pipe Protection with End Closed
Leads to Instrument
Extension of Couple
Cold End of Couple

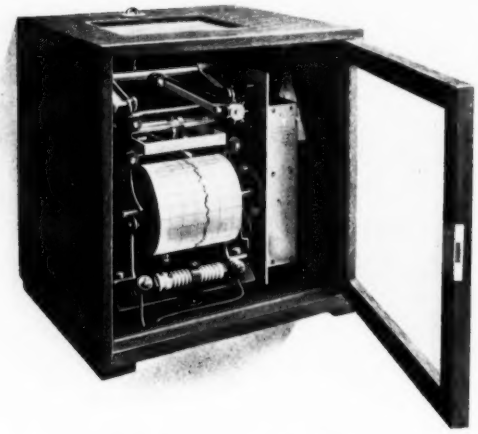
METHOD OF APPLYING ELECTRIC PYROMETER TO HARDENING FURNACE.

American Gas Furnace Co. and Bristol Pyrometer.

A system for observing and maintaining temperatures in a large battery of furnaces, something on this plan, is in use in one of the largest commercial tool-making plants in the United States. Each furnace, of whatever kind, is provided with a thermo-couple poker



PLAN AND SECTION OF BROWN & SHARPE COMPANY'S HARDENING AND ANNEALING FURNACE, SHOWING BRISTOL PYROMETER.

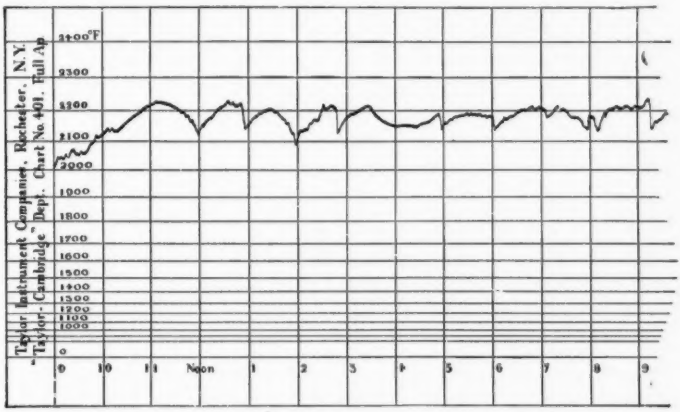


THREAD RECORDER IN ITS CASE.
Taylor Instrument Co.

and all are wired to a switchboard, from which each is in turn cut into the circuit of the indicator (a recorder also could be in the circuit) and its temperature observed by the person designated for this work. If not at the standard temperature required in the work then in hand, that is to say, if more than five degrees off, a crank is turned which at the same time indicates the temperature upon the indicator board above the temperature indicator and upon an indicator placed immediately in front of the furnace. The operator, warned by a bell, notes the temperature, and regulates the furnace accordingly. The indicator boards are so placed that the center line always shows the standard temperature required for the work being done. This arrangement does away with the need for separate indicating instruments for all the furnaces, but obviously requires the continuous services of an attendant. It has the further advantage of relieving the furnace operator of the distraction occasioned by frequent readings of the pyrometer, when he has to do this himself. In a small plant, of course, some simpler means are necessary. In general, one indicator is sufficient for a small plant, though it is very desirable that a recording indicator be provided also.

Records of this sort are more important than they at first thought may seem. It is a well established fact that any operator at work requiring the maintenance of uniform temperatures, will more carefully regulate his furnace and take greater care to preserve uniformity if he has a continuous record staring him in the face and constantly reminding him of departures from the required standard, than he will without such a record, even if he has an indicator before him which can be consulted at will. It is in the study of conditions, however, and the determination of those most suitable for

the particular work in hand—a study which should precede and upon which the working out of each separate problem in high-speed tool making should be contingent—that the recorder is most useful and necessary. In the case, for example, of determining the critical point of a given steel, the curve is much more conveniently and accurately made by an automatic recorder than it can be plotted from frequent indicator readings. The recorder so made (there should naturall be more than one, to insure accuracy) then serves as a basis for subsequent heat treatments. The form of the record is not very material, though one with rectangular co-ordinates, like the Cambridge Thread Recorder, is more conveniently read than one with curved co-ordinates, like the Bristol. The latter form usually is simpler in its mechanism.



RECORD MADE WITH FÉRY PYROMETER AND THREAD RECORDER.
Taylor Instrument Co.

The critical point of a steel can be easily ascertained by heating it in an ordinary furnace suitable for hardening, though it is frequently more convenient to do this in the office or laboratory with a small electric or gas furnace. The former, all things considered, is the cleaner and more convenient. The pyrometer "poker" for use in determining the recalescence and decalescence (critical) points, whatever the furnace used, is preferably of a special form which may be inserted into a hole drilled into the center of the specimen piece of stel and firmly held there, or flattened so as to be clamped tightly between two pieces of the steel, these being held together by dogs or screws, preferably the latter. A recorder is not only more convenient in connection with this apparatus, but is almost necessary in making a permanent record for future reference.

DISTRIBUTION OF INDIRECT COSTS BY THE MACHINE-HOUR METHOD.

By Gershom Smith.

The statement of the bearings of this discussion that is made in Mr. Smith's opening paragraph needs no amplication. His article will be read with interest, especially if it is studied in connection with Mr. W. M. S. Miller's contribution to our issue of February last, and Mr. A. Hamilton Church's series on the Distribution of Expense Burden which appeared in THE ENGINEERING MAGAZINE, July-December, 1901, and has lately been reissued by us in book form.—THE EDITORS.

POSSIBLY the most important phenomenon modern statistical accountants must reckon with is the rapid increase in the range and importance of mechanical operations, and the constant displacement of hand labor by machine work. Wage costs, heretofore so largely relied upon as a basis for estimate and distribution of indirect charges, are steadily waning in relative value in the industrial formula, and are constantly becoming more inseparably bound up with machine costs. It is not the operative, but the operative *plus* his machine, that we must regard as the producing unit. Hence, so far as manufacturing costs are concerned, our fundamental measuring rule becomes increasingly inaccurate if we continue to divide it by the scale of men's wages or men's time; we need a new scheme of graduation, which will be commensurable throughout with the scale upon which our costs of production are actually built up. This new unit of division is found in the machine hour, and its applicability to use in the distribution of indirect cost is briefly outlined in the following pages.

Shop costs have three main divisions:

1.—Raw Material; that is, the material on which shop work has to be done to fill the order.

2.—Direct or Productive Labor.

The sum of these two is termed "Direct or Prime Cost."

3.—Indirect Cost, or Shop Expense, which when added to the Direct Cost, equals the total manufacturing cost.

Besides these there are commercial expenses, namely, the cost of marketing the product, and general administration charges not included in manufacturing, besides fixed charges such as interest on bonds, etc.

In manufacturing cost, while it cannot be said that any cost keeping if correct is easy, the direct cost is the simplest matter to handle, as most foremen can give an approximate idea of the material and direct-labor cost, the latter being frequently piece work. This statement is not intended to minimize the importance of correct cost keeping in any respect, but to draw attention to the most important, because most elusive, part of the cost keeping—namely, what is variously described as "Indirect Cost," "Shop Expense," "Overhead Expense," "Expense Burden," etc. The name is unimportant, but what is covered by the name is of supreme importance, and ignorance on this subject, I suppose, has been one of the principal causes for the ruinous competition which (while the path is strewn with the remains of many who, through ignorance, have lost in the fight), has also frequently given the consumer an entirely erroneous impression on the subject; the result being that the manufacturer who through proper consideration of and provision for all items of cost, has insisted on living prices for his product, is frequently looked upon as a robber. Briefly then, correct cost keeping makes competition more intelligent.

The third division defined above includes all costs between the first division or direct cost, and the complete cost ready for shipment. Some of the principal items in this division are:

Superintendence,
Indirect or non-productive labor,
Cost of power, light, and heat,
Depreciation of buildings,
Depreciation of power plant and power-transmission plant,
Depreciation of machines,
Lubricants,
Supplies and similar items.

It is comparatively easy to determine what this indirect cost amounts to in a given period, but the subject for consideration here is the best means of distributing such cost to the individual orders.

In every plant there is a tendency to use some account as a dump, and "Indirect Expense" is a very convenient receptacle for this purpose unless carefully watched. The material and labor can be regulated by foremen and superintendents much more easily than the expense account, and it therefore behooves the accounting department to watch the expense account carefully and notify the superintendents of any undue increase.

In a plant which need not be closely located, the answer was frequently made to enquiries as to what account certain expenditures should be charged: "General expense—to hell with it!" Later, when a system was installed in which the item "General Expense" did not occur, and in which the only account containing the word "general" referred to the main-office accounting department in a distant city, an item charged by the works against the general accounting department was investigated, with the result that it was found that the foreman in charge of repairs to one of the bridges at the works, failing to find his old friend "General Expense" in the schedule of accounts, used the only account he could find containing the word "general."

Here let me emphasize the fact that no matter what the method of distribution, the principal essential is that all the indirect cost be distributed to the product for the period under consideration. I knew one concern who, when I visited their plant and asked how they distributed their shop expense, informed me that ten years previously they had figured that this item was a certain percentage of their direct labor, and had been using the same percentage ever since without checking it. That was a factory whose product up to that time sold at their own prices; since then, owing to the necessity arising from competition, they have adopted an up to date system. Another concern figured 10 per cent on labor and material, and when it was pointed out that this did not cover the actual expense, explained that the balance was charged against the profit.

There are three principal methods of distributing Indirect Expense, namely:

By percentage of wage cost or value of direct or producing labor.

By hours of direct or producing labor.

By machine hours.

It is the third method that I propose to discuss, but before doing so it seems advisable that I should say something of the other two methods, so as to explain my reason for preferring the third.

Let me explain, however, in preface, that these three methods of expense distribution refer particularly to machine-shop practice, where a number of machines are working on a number of different orders, rather than to a rolling mill, for instance, where the product is more or less fixed, varying only by sections, thicknesses, etc., and where the expense under proper sub-divisions can be apportioned on the basis of unit of production, tons, pounds, etc.

Distribution of Expense by Percentage of Value of Direct or Producing Labor.

By this method the distribution is made by first ascertaining the ratio that the indirect cost bears to the direct labor, and then apportioning the cost by this percentage on direct labor charged against each order. The method is good to the extent that it absorbs the whole expense, but limited by not taking into consideration the different elements that enter into the direct-labor cost. For instance, supposing that a 25-cent per hour man takes 2 hours to do a certain piece of work, and that the indirect cost has been ascertained to be 100 per cent of the direct labor; then the labor and expense of the work would be 2 hours at 25 cents, which equals 50 cents, plus 100 per cent loading for indirect expense, making a total of $1.00. If, on the other hand, the same work be done by a 12½-cent per hour man in 4 hours, the same items of cost would be 4 hours at 12½ cents, which equals 50 cents plus 100 per cent loading for indirect expense, again totalling $1.00—the same cost, although it stands to reason that the indirect cost for 4 hours would be greater than for 2 hours.

Again, suppose that the 25-cent per hour man is working on a moderate priced lathe, whereas there are in the same shop five automatic screw machines, all five operated by a boy at 10 cents per hour; on the percentage-on-wages plan (still assuming 100 per cent shop expense) the labor and indirect cost would amount to 50 cents per hour in the case of the man, while the boy with his five machines would only be charged at 20 cents per hour, including expense. This is manifestly absurd, and yet it is the method usually applied in machine-shop practice.

The percentage-on-wages plan is particularly deceptive when for any cause the direct labor to produce a given product is reduced. I have frequently been asked to account for a rise in percentage of expense, and on investigation have found that owing to the installation of a piece-work or premium system, or of labor-saving machinery, the direct labor has been considerably reduced, while as the expense remains stationary, the percentage has of course risen, and those who are estimating on the basis of the old percentage find their figures unreliable

Distribution of Indirect Cost Per Producing Hour.

This comes much nearer to being a correct method of distribution than the percentage plan, the total indirect cost being divided by the number of producing hours of labor in a given period, and the unit

thus arrived at being added to the costs according to the number of producing hours charged to the job. Thus, in the first example previously given, assuming an indirect-cost unit of 25 cents per hour, the cost of the 25-cent per hour man's work would be $1.00 for 2-hours' work, while that of the 12½-cent per hour man would be $1.50 for 4-hours' work. The method, however, is weak in that it does not take into consideration the value and expense of the equipment used, as will be seen by referring to the second example cited, in which the lathe hand at 25 cents per hour would be charged to the costs at 25 cents for labor plus 25 cents for indirect cost, a total of 50 cents, while the cost of the boy operating five automatic machines would be charged at 10 cents for labor plus 25 cents for indirect cost, a total of 35 cents, which again will be seen to be absurd.

Distribution of Indirect Cost Per Machine Hour.

This I think appeals to a superintendent or engineer, as well as to the accountant, as a more equitable method of distribution than either of the foregoing, the chief objection to it being that the first installation of the system is not quite so easy. The natural question that will occur to any one not acquainted with this method will be, how do you determine your rates? This I will endeavor to explain by stating how we started this method of distribution about four and a half years ago, in the shops of the company with which I am connected.

The first step was to ascertain the floor space of the shop under consideration, and to divide this space into the yearly depreciation on the building in order to ascertain the yearly value of floor space per square foot. Next, it was necessary to determine the annual depreciation of the power plant and power-transmission machinery, also general machinery for common use throughout the shop, such as overhead cranes, etc., also expense of a general nature, such as heat, light, superintendence, non-producing labor (that is, laborers), etc.

The next step was to ascertain the square feet of floor space occupied by each machine, and to apportion to this machine its pro rata charge of the aforementioned items, on the basis of its square feet of floor space.

It should be explained here that care must be exercised in apportioning this floor space, as some machines require considerably more clear space around them than others for the handling of work. The necessary information on this point can be obtained from the super-

intendent or foreman. Next, the depreciation on the cost of the machine itself is ascertained, including installation and necessary equipment such as counter-shaft, belting, motors (in case of direct-driven machinery), tools, and machine fixtures. To this must be added the proportion of cost of power, this figure being furnished by the mechanical superintendent and based on horse power, also supplies, and all expense directly applicable to the machine.

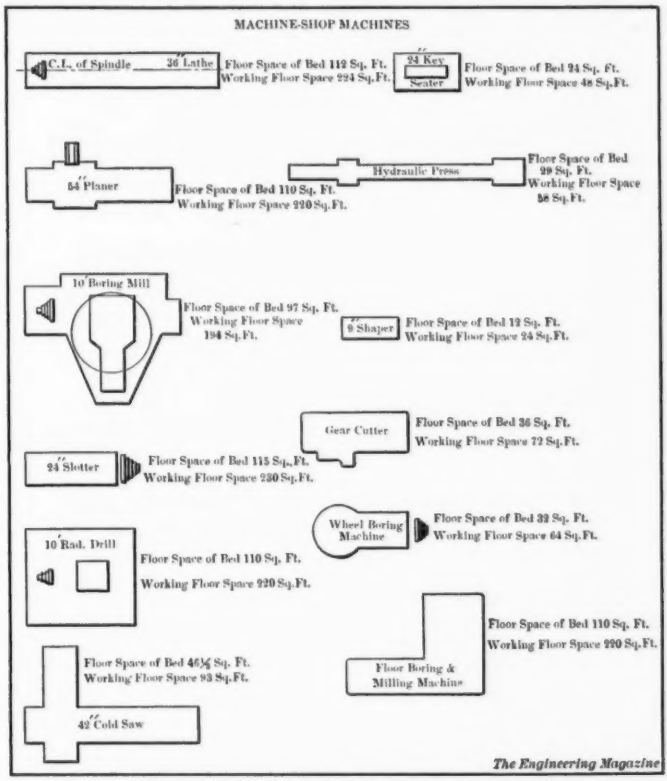

MACHINE-SHOP MACHINES
C.L. of Spindle
36" Lathe
Floor Space of Bed 112 Sq. Ft.
Working Floor Space 224 Sq.Ft.
24" Key Seater
Floor Space of Bed 24 Sq. Ft.
Working Floor Space 48 Sq.Ft.
54" Planer
Floor Space of Bed 110 Sq. Ft.
Working Floor Space 220 Sq.Ft.
Hydraulic Press
Floor Space of Bed 29 Sq. Ft.
Working Floor Space 58 Sq.Ft.
10" Boring Mill
Floor Space of Bed 97 Sq. Ft.
Working Floor Space 194 Sq.Ft.
9" Shaper
Floor Space of Bed 12 Sq. Ft.
Working Floor Space 24 Sq.Ft.
Gear Cutter
Floor Space of Bed 36 Sq. Ft.
Working Floor Space 72 Sq.Ft.
24" Slotter
Floor Space of Bed 115 Sq.Ft.
Working Floor Space 230 Sq.Ft.
Wheel Boring Machine
Floor Space of Bed 32 Sq. Ft.
Working Floor Space 64 Sq.Ft.
10" Rad. Drill
Floor Space of Bed 110 Sq. Ft.
Working Floor Space 220 Sq.Ft.
Floor Space of Bed 110 Sq. Ft.
Working Floor Space 220 Sq.Ft.
Floor Boring & Milling Machine
Floor Space of Bed 46½ Sq. Ft.
Working Floor Space 93 Sq.Ft.
42" Cold Saw
The Engineering Magazine

DIAGRAM OF APPORTIONMENT OF SPACE TO INDIVIDUAL MACHINE TOOLS.

Repairs to plant I prefer to charge against the depreciation reserve account, which is credited when depreciation is charged.

Having taken all such expense into consideration, based on the totals of one year, the next step is to ascertain by careful enquiry (to be verified and if necessary corrected later from actual data),

D 976

Lyter, Cyrus

Mar. 14th 1909

Night and Over Time

Time Started: 7

NO TIME ALLOWED UNLESS REPORTED ON THIS CARD

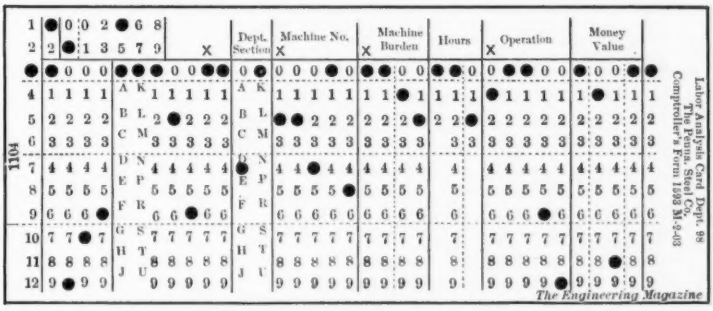
	Time Finished	Dep't Charged	Order No.	Dep't Sect'n	Machine No.	Machine Burden	No. of Pieces	Time	Operation	Rate	Value
P. M. In	7 30		2600	D	22405	12	3	2	10069	06	18
P. M. Out	8 30		2705	H	56405	25	8	1	40212	04	32
A. M. In	11 00		3160	U	62505	60	1	2 2	31030	75	75
A. M. Out	12 00	N	907	E	12608	40	2	1	90068	26	26
								5			
Extended By C-					Total	1 37		Checked By 7		Total	1 51

Day Time 31 97 9 92

The Engineering Magazine

TIME CARD FOR DAILY REPORT. THE TABULATING CARD (PAGE 391) IS PUNCHED FROM THIS RECORD.

the number of hours per month or per annum which each machine will run under normal conditions. The method of verifying and correcting will be explained later. Having ascertained the number of hours per annum, we use this as a divisor, and the total yearly cost of the machine (ascertained as described), as the dividend, the resulting quotient giving the machine's hourly rate. As it would be impractical to operate this plan with a different rate for every machine in the shop, the machines have been divided into ten groups, with a different rate for each group, and the machine is assigned to the group nearest to its ascertained rate. The desire is to provide a slight leeway per hour on each machine to cover unforeseen expenses, and also to provide a reserve in normal times which can be drawn on in subnormal times, and thus to keep the expense rate fairly even and not increase it as would otherwise be necessary at a time when costs can least afford the additional burden. This reserve, however, is not a necessary part of the system, and if the management desire, it can be disposed of monthly by dividing it by the productive hours and applying it to the orders in process for the time under consideration.



TABULATING CARD. PUNCHED BY BOYS, FROM RECORDS ON THE TIME-CLOCK CARD SHOWN ON PAGE 390.

It may now be of interest to describe our method of operation after the machines have been assigned to their proper groups.

The time of each workman is reported daily on a time-clock card. A time check will answer where time clocks are not used. The card gives the machine number, operation number, number of pieces, and hours on each piece of work completed. This information is supplemented in the office by extending the items showing the man's earnings and machine earnings, the machine number indicating the machine rate of the latter. The total time accounted for must equal

the time worked as shown by the clock registration; the card is then handed to a punch boy (where tabulating machines are used), or to an analysis clerk where they are not; but as our application of the system under consideration has the advantage of the tabulating equipment, this description will be made accordingly.

The tabulating card is provided with columns showing:

Date (month and day)
Man number
Department and order number
Department section for which work is done
Machine number
Machine burden (machine earnings)
Hours
Operation number (planing, drilling, etc.)
Money value (man's earnings).
Punch-boy number.

As we are considering only machine earnings, we will skip the description of handling these punched cards for pay-roll and direct-cost purposes, and will place them in the automatic tabulating machine, to ascertain the amount of machine earnings, which amount, when ascertained, will be charged on our ledger to "Product in Process," and credited to "Machine Earnings."

The account "Machine Earnings" has previously been charged with the total indirect expense of the department for the month, including depreciation, and the balance of the account will therefore show whether we have charged our costs with sufficient or with an excess amount of indirect cost. If the difference is of sufficient amount, the cards are placed in the automatic sorting machine and sorted at the rate of 12,000 per hour per column to the machine group, only two columns having to be sorted as they indicate the machine rates.

The sorting being completed to machine rates, the cards are placed in the automatic tabulating machine, and the earnings of each group are recorded, if any group shows an abnormal excess or insufficiency of earnings, that group is sorted to machine numbers and the actual machine or machines showing the discrepancy are thus selected, with a view to finding the reason for the figures. Sometimes it will be found that there are extraordinary reasons for this, which apply only to the month under consideration; at others an error in assigning the machine to the particular group is discovered and corrected.

This record of machine earnings can easily be kept by hand in shops where the business would not warrant the installation of the tabulating equipment.

In this summary I have described only the general or controlling account. Of course the individual costs, both direct and indirect, are tabulated to order numbers, the sum of which tabulation must agree with the controlling accounts.

Now to conclude, it is fair to consider what others have to say as to this method of distribution. I have heard one commentator refer to it as the "machine-hour fallacy," and another say it was simply "guess-work." If the reader is not convinced that neither of these statements or definitions is correct, this paper has utterly failed in its mission.

After four-years experience, those who know the results by actual contact are more enthusiastic than ever. In making this statement, of course it will be borne in mind that experience teaches, and we do not pretend to have reached perfection. On the contrary, we are frequently finding inequalities which have to be adjusted, but which in the case of the blanket methods—namely, percentage or productive-labor hours—would never be brought to light, although existing to a much greater degree.

In "The Proper Distribution of Expense Burden"* by A. Hamilton Church, published in 1908, which book will be very interesting and instructive to those desiring to look into this matter in more detail, on page 36, the statement is made that the machine rate may be looked upon as belonging to the "Silurian epoch of shop accounting," and further "it is the ichthyosaurus of expense systems." These statements naturally are likely to discourage one who thinks the book is going to treat of this method of distribution; but on reading further we find that Mr. Church has an "ideal" system which to one who has carefully studied the situation is simply a machine-rate system scientifically applied, while the animal described in the Century Dictionary as a "gigantic extinct marine fish-like reptile, having an enormous head, no obvious neck and a tapering body with four paddle like flippers, and probably a fin-like expansion of the caudal region," represents the same system unscientifically applied. The "ideal" system, with the exception of some details, is essentially the same as has been in use under my supervision for over four years.

* Originally published as a series of articles in this magazine, July—December, 1901, and revised and republished in book form by THE ENGINEERING MAGAZINE, 1908.

The above is not intended as an unfriendly criticism of Mr. Church's book which is without question the best publication on the subject discussed in this paper.

Mr. Andrew A. Murdock in his article "The Proper Treatment of Machine Costs," in the *Journal of Accountancy*, December, 1906, says:—

In conclusion, let me emphasize the increasing importance of recognizing machine labor as a basic element of cost. The tendency of the age is undoubtedly to supersede manual labor in every possible way by introducing machinery to do the work; so that while the direct pay roll becomes gradually less and less in proportion to the factory output, the expenditure on machinery keeps on growing more and more. The custom is to ignore machine work entirely as an element of direct cost, arbitrarily fixing the latter as composed only of material and manual labor, and loading all machinery and power expense, including repairs and depreciation, as a percentage on the amount of manual labor only. As an evident consequence of this method, the more hand work we put on a job the more will be the loading for machinery expense; and the more actual machine work we introduce, the less will it bear of the loading; or to carry the anomaly to its legitimate limit, a job done entirely by hand would bear a full share of the machinery cost, whereas a job done exclusively on the machine would bear none.

As a concrete example, take the case of an automatic screw machine turning out small completed parts by the score every hour. Six such machines will barely occupy the time of one man, and on an ordinary cost system the product would be charged with a sixth part of his wages and loaded in proportion, whereas if the operations were entirely done by hand not only would the direct cost be more, but the loading for machinery expense would be proportionately greater, although as a matter of fact, no machine work had been done at all.

Surely nothing more need be said to prove that the old method is incorrect and liable to produce misleading results, and to establish the principle that the work done by a machine must be measured and figured as one of the basic elements of prime cost, on the accuracy of which the whole superstructure depends.

SMOKE PREVENTION OR SMOKE CONSUMPTION.

By Harold V. Coes.

Mr. Coes' discussion of smoke prevention in stationary steam-boiler practice, in the first instalment here presented, recapitulates the causes of smoke and the principles of smokeless combustion, and describes the methods and devices by which smokeless combustion is assisted or attained in hand-fired furnaces. A concluding article, to be presented next month, will classify mechanical apparatus for boiler firing, describing the principal types in the various classes, with an estimate of their usefulness in solving the problem of smoke prevention. Closely related to Mr. Coes' article this month is a review on another page of this number, which summarizes the conclusions arrived at by experts of the Technologic Branch of the United States Geological Survey after extended smoke-prevention investigations both in industrial plants in a number of leading cities of the country and at the Government fuel-testing plant at St. Louis.—THE EDITORS.

PERIODICALLY, the general public has foisted upon it a chemical preparation for preventing smoke and for giving supposedly high economic values for coal combustion. The questions naturally arise: What is meant by smoke consumption? Is there such a thing? The whole controversy hinges on fundamental principles. This idea has been kept in view throughout this discussion.

That the problem of smoke abatement is of great importance is evidenced by the fact that such cities as New York, Boston, Philadelphia, Chicago, Detroit, Cleveland, and Milwaukee have passed smoke ordinances and appointed smoke inspectors.* Whether such ordinances are legal or not depends upon the distinction between smoke that can be abated and smoke that cannot—in other words, upon the distinction between necessary nuisances and statutory nuisances. Whether society can pass laws to prevent those things which are of themselves perhaps harmless, but which in a large community are depreciatory of the interests of others, it is not the purpose of this article to discuss. If, however, it can be demonstrated that by the scientific abatement, or prevention of smoke, not only is the community benefited but a large saving is made to the steam user himself by the increased economy of his plant, than we have gone far towards the proper solution of the problem. To accomplish such a result, however, the enforcement of the ordinance and the supervision of steam plants should be under the direction of officials possessing

* Smoke-prevention laws are not new. They date back to the year 1306 in London, when a royal edict fixed the punishment as death by hanging for allowing smoke to escape from a chimney.

the requisite technical and practical acquaintance with the subject. The whole trouble is that both sides have been obstinate, and there has been a lack of both wise supervision and proper intelligence. The cities have been imposed upon by smoke producers who possessed sufficient political influence to dodge the issue, and manufacturers or steam users have been harassed by worthless statutes or ordinances and still more worthless smoke inspectors.

The actual damage done by smoke or its constituents may seem out of place here, and yet a consideration of this point is necessary in order to make the discussion complete. The Municipal Committee of the City of Cleveland Chamber of Commerce, in their report of March 19, 1907, give actual estimates of the damage done by smoke, as follows:—

The presence of coal smoke in large quantities constitutes perhaps the greatest hindrance to the highest development of civic beauty and refinement. Its effect is seen in all plant life.

No definite estimate has been made of the amount of loss of vegetation resulting directly from the presence of smoke and gas in the air, but the St. Louis Forestry Department figures conservatively an annual loss of 4 per cent and these figures may doubtless be assumed for Cleveland.

To a considerable extent, the architectural effects of our buildings are destroyed by damage from this source. Buildings of almost every material are in a few years brought to a common level—a grimy hue, which robs them of their distinction. It is only through constant treatment by special process that stone buildings can be restored to their original color, and this process is frequently harmful to the surface and durability of the stone. Painted buildings in a short time lose their color because of the coating of soot and the effect of chemical gases.

The most tangible results from the smoke nuisance can be shown perhaps in the financial loss to the community. There are approximately four hundred retail dry-goods stores in Cleveland, doing a business of from $10,000.00 to $3,000,000.00 or $4,000,000.00 a year. The owners of some of these stores estimate (and the same estimate is given in other cities), that, of all the white goods sold, a clear loss of at least 10 per cent must be figured. The gentlemen's furnishing stores showed $15,000.00 annual loss,—due to repainting, decorating, laundry, wear and tear on clothes, etc.

Finally, the report says that the annual tribute which Cleveland must pay to the smoke nuisance is "a sum sufficient, in a single year, to equip all plants, not so provided, with smoke preventing devices."

The above is a general statement of the problem with which we have to contend. We will next turn our attention to the causes of smoke. In order to understand them, we must review the principles of combustion as particularly applied to bituminous coal. Suppose, for example, a bituminous coal containing 25 to 35 per cent of volatile* hydrocarbon is fired onto a

* Chart 1 shows the relation of volatile matter to fixed carbon and other constituents.

bed of incandescent fuel; what takes place? The layer of coal immediately in contact with the hot fuel, begins to break up along its laminated faces and the contained moisture is turned into steam. The hydrocarbons are next distilled and pass up through the green coal, undergoing a reduction in temperature. If now for any reason, at the time of firing or immediately afterwards, the air supply is insufficient, on account of the caking of the coal and the choking up of the pores in the fire-bed, or if the air is too cold to support ready combustion of these gases, or, as is generally the case, it is imperfectly mixed, then the hydrocarbons reach the cold boiler tubes (if there is no arch) where they are still further reduced in temperature, and as they are too cold to ignite, only partial combustion consequently takes place.* The carbon, precipitated in the form of soot, is carried along with the other products of combustion and goes up the stack as black smoke. Prof. W. D. Ennis, in his able series of articles in THE ENGINEERING MAGAZINE, stated recently that this incomplete combustion is a distinct loss, on account of the decreased furnace temperature. Complete combustion of these volatile hydrocarbons can be produced only under the following conditions:—

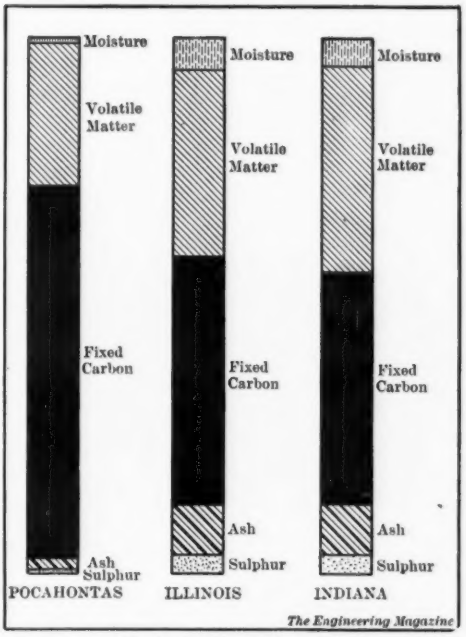


CHART I. DIAGRAM SHOWING RELATION OF VOLATILE MATTER TO THE OTHER CONSTITUENTS OF WELL-KNOWN COALS,
R. H. Chamberlain, "Boiler-Room Economy," 1907.

1.—A sufficiently high temperature, say 700° C or 1300° F, to effect ignition of the gases;

* Charts 2 and 3 show the effects of incomplete combustion, air supply, elevation of furnace temperatures.

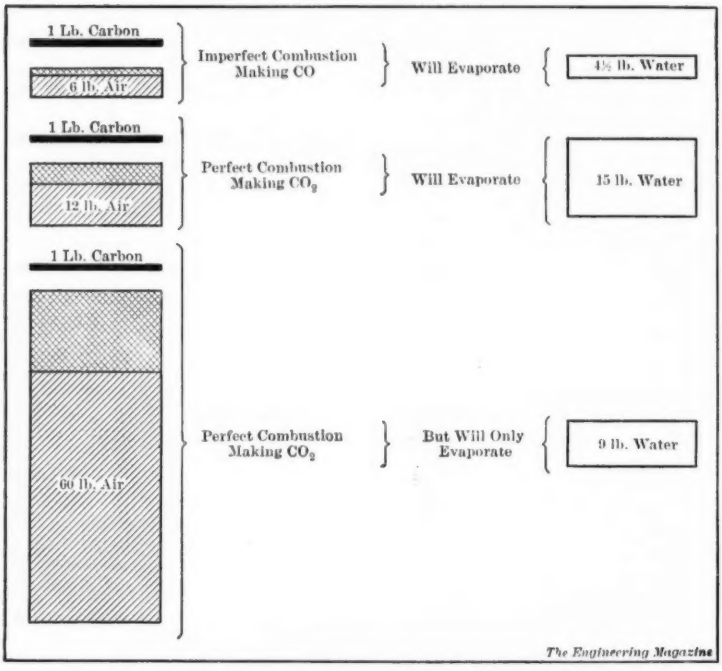


CHART II. DIAGRAM SHOWING THE EFFECT OF AIR SUPPLY ON COMBUSTION.
R. H. Chamberlain, in "Boiler-Room Economy," 1907.

2.—A sufficient and properly applied amount of air, to combine with the carbon to burn it to CO_2 and with the hydro-carbons;

3.—A good mixture of the air and hydrocarbons.

If combustion does not take place under these conditions, then the carbon will separate out as shown by the following formulæ:

$$2CH_4 + 2O_2 = C_2 + 4H_2O$$
$$C_2H_4 + O_2 = C_2 + 2H_2O$$
$$2C_2H_2 + O_2 = 2C_2 + 2H_2O$$

Carbon, soot and smoke thus formed can be burned only, and even then with difficulty, in a properly constructed furnace, with sufficiently high ignition temperature; in other words, the above reactions must be prevented.

Causes of Smoke.

Smoke may be made in two ways:—

1.—By direct distillation of tarry condensible vapors from coal without burning;

2.—By the partial burning or splitting up of hydrocarbon gases, the hydrogen burning and the carbon being left as smoke or soot.

The direct cause of smoke is the fact that the gases distilled from the coal are not completely burned in the furnace before coming in contact with the surface of the shell or tubes, which chills them below the ignition temperature. Now these gases are the volatile hydrocarbons, which all bituminous coals contain to a greater or less extent, and which are driven off when the coal is heated. The percentage of this volatile matter varies all the way from 3 per cent for the Eastern anthracites to as high as 50 per cent for the Western

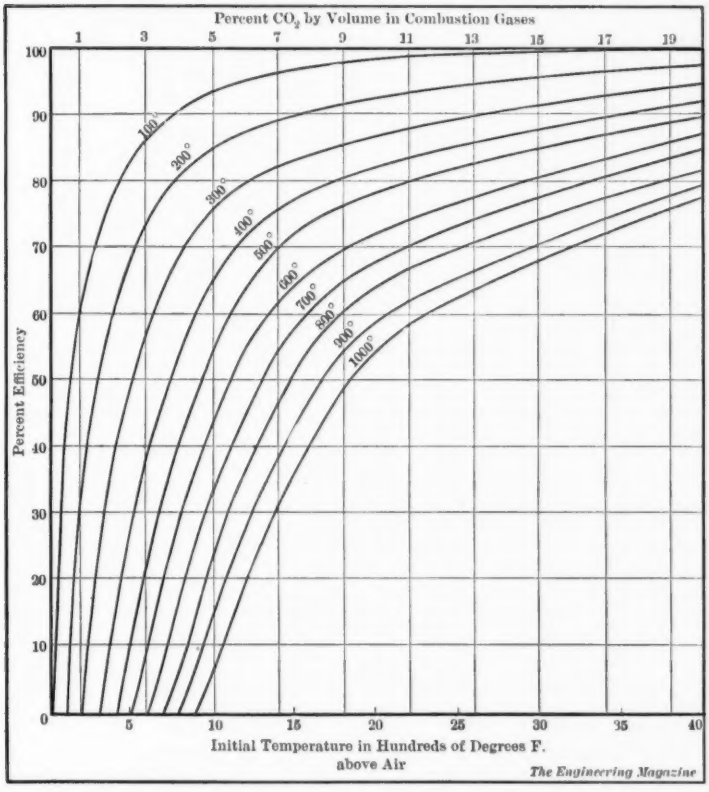


CHART III. DIAGRAM SHOWING RELATION BETWEEN FURNACE COMBUSTION AND RESULTANT EFFICIENCY, WITH A TEMPERATURE RANGE OF ESCAPING GASES CORRESPONDING TO VARIOUS BOILER CONDITIONS. THEORETICAL AIR PER POUND OF COAL.

lignites. The larger the percentage of volatile matter, the greater the liability to smoke production, other things being equal, and the more difficult is smoke prevention. The behavior of these volatile gases during combustion is complex. There are good reasons for supposing that a hydrocarbon, at a sufficiently high temperature, is decom-

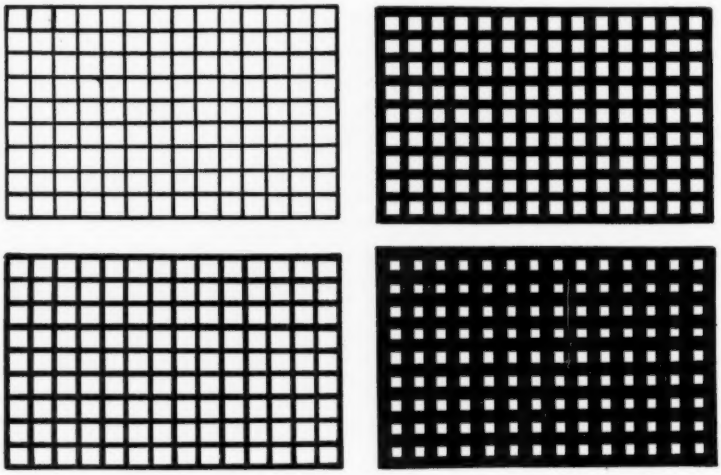


FIG. I. RINGELMANN SCALE FOR GRADING DENSITY OF SMOKE. SCALE ABOUT 1/3.

A complete set of cards includes one all white and one all black. The four shown are based on paper divided into squares one centimeter to the side, the thickness of the lines being, respectively, 1, 2.3, 3.7, and 5.5 millimetres. The cards are hung in line with the chimney about 50 feet from the observer, at which distance the lines become invisible and the cards appear to be of different shades of gray. In making tests, the observer records at intervals of one minute the number of the card most nearly corresponding to the color of the smoke issuing from the chimney.

posed into its elements. The carbon particles are seemingly averse to combining with oxygen, except under favorable conditions; if the temperature is too low or the air supply insufficient, the carbon refuses to combine, and appears later as soot or smoke, thus:

$$C_2H_4 + 2O = 2H_2O + 2C$$

Ethylene + Oxygen = Water + Carbon or { Smoke. / Soot.

That is, we must have sufficient air at a high temperature. The whole question revolves about the point of perfect combustion.

We have successfully solved these problems for oil. We started with smoky torches, as the air could not get at the body of oil in the center of the wick. We then used a flat wick—that is, we gave the oil more surface for the air to act on. We then used a hollow cylin-

drical wick, air acting on both sides. The final step was the center core or argand lamp, which first heated the air for the wick supply. But when we try to force the lamp by turning up the wick and thereby increase the oil consumption, we get into trouble immediately by producing smoke. We have exactly these same conditions to meet in the combustion of solid fuel. In other words, as Mr. W. D. Ennis points out, if coal is to be burned with maximum economy and without smoke, it must be supplied with the correct amount of air, at the proper temperature.

FURNACES AND SETTINGS FOR BURNING COAL WITHOUT SMOKE.

In his book on "Steam Boiler Economy," Wm. Kent says:—

Coal can be burned without smoke, provided:—

(a) The gases are distilled from the coal slowly;
(b) That the gases, when distilled, are brought into intimate contact with very hot air;
(c) That they are burned in a hot fire-brick chamber;
(d) That, while burning, they are not allowed to come in contact with comparatively cool surfaces, such as the boiler tubes.

Mr. A. Bement says:

Professor Kent's requirements may be modified as to two features as follows:—

(a) That the evolution of gas from the coal shall proceed uniformly;
(b) That the gases, which are distilled uniformly from the coal, shall enter a fire-brick chamber of either sufficient length to allow the flames to become entirely consumed naturally, or that the chamber be provided with such auxiliary mixing and baffling devices as will cause the gases to be artificially mixed together before the exit of the chamber is reached.

To obtain the conditions for preventing smoke, it is necessary:

1.—That the coal be delivered into the furnace in small quantities at a time;

2.—That the draft be sufficient to carry enough air into the furnace to burn the gases as fast as they are distilled;

3.—That the air itself be thoroughly heated, either by passing through a bed of white-hot coke, or by passing through ducts in hot brick work, or by contact with hot fire-brick surfaces;

4.—That the gas and air be brought into the most complete and intimate mixture, so that each particle of carbon in the gas, before it escapes from the furnace, meets its necessary supply of air;

5.—That the flame produced by combustion shall be completely extinguished by the burning of every particle of the carbon to CO_2.

It is impossible, under ordinary conditions, with coal containing over 30 per cent of volatile matter, and with a water tube boiler, with tubes set close to the grate and vertical gas passages, as in anthracite settings, to prevent smoke, even by the most skillful firing A Dutch oven setting, or a longitudinal setting with fire-brick baffle walls is a good smoke preventing furnace, when properly fired.

Probably, of the above mentioned conditions, the most difficult to obtain in practice is the proper mixing of the air and gas. Numerous mechanical-mixing devices and steam and air operated jets have been used, to a certain extent, with some success, but they are not universally used. Some of these will be described later. Down draft furnaces and mechanical stokers of many different types (which will also be discussed later) are successfully used for smoke prevention, and when properly designed and installed and operated, generally at a rate not above that for which they are designed, prevent smoke.

Hand Firing.

It is the custom in the United States to depend upon mechanical devices for the abatement of smoke. Quite the opposite seems to be true in England and on the Continent, where much attention is paid to proper methods of hand firing and where, in some places, schools are maintained for the instruction of firemen.

It may be broadly asserted that an intelligent and well trained fireman will often obtain better results from indifferent coal than will a less expert man from a superior coal, thus vitiating the manager's careful buying of coal under rigid specifications, and making him wonder whether the extra cost per ton, due to the carrying out of the tests under the specifications, is worth while, when his neighbor, who is buying an inferior coal, gets better results. If the manager would make a study of his fire-room operating conditions, he would probably ascertain the cause of the discrepancy.

This is not denying the fact that the quality of coal used, as well as the design and construction of the boilers, furnaces, settings, etc., play an important part in the problem; what it is particularly desirable to lay stress upon is the important factor, the personal equation.

It is a fact known to almost every engineer that the proper training of firemen has been sadly neglected. An intelligent, careful, trained fireman is worthy of good pay, but most firemen waste more than their daily wages because of ignorance or carelessness in handling their fires. This is particularly true in small plants, and small plants predominate in every city and are generally the worst offenders against the smoke laws. In these plants, the saving due to mechani-

cal stokers is small. Neither can we expect our firemen to know intuitively the fundamental laws of the chemistry and physics of combustion; if he does, it is unlikely that he will stay long at that occupation. Muscle and physical endurance have been the chief constituents in the make-up of a fireman, and the long hours and strenuous work have not attracted an intelligent class of men.

In connection with government buildings in Prussia, for which the government makes an annual appropriation for the instruction of firemen, it is required that, "as far as in any way feasible, care should be taken that only such persons as have satisfactorily managed furnaces for a considerable time, shall be employed as independent firemen. If these persons have not gone through a satisfactory course at a firemen's school, opportunity should be given them, as far as possible, to attend one." This is the Continental view of the subject. From observations and study of the problem, I believe that if instructional courses were given to firemen, and if employers would give preference to those persons who have been properly trained and can give documentary evidence of the fact, the result would be not only a mitigation of the smoke nuisance, but also a saving of a large percentage of the present waste through imperfect combustion.*

In St. Louis, the Smoke Abatement Department causes to be posted in every boiler room a list of "Directions for Firing":—

1.—Fire frequently in small quantities and at regular intervals.
2.—Break up lumps to fist size.
3.—Carry a level surface over entire grate.
4.—Avoid thin and bare spots on grate.
5.—Keep the fires clean.
6.—Fire one door at a time, and wait until that fire is in good shape before charging the other door.
7.—Leave the furnace door slightly ajar for one minute after firing.

These rules are logical and good if firemen will follow them, but it is almost impossible, with the help now at hand, to maintain this standard for any length of time.

To show what effect trained stokers have on coal bills, the results obtained by the Hamburg "Verein für Feuerungs-Betrieb und Rauchbekampfung" are quoted. This is a voluntary organization of steam users, who employ a staff of experts for the special work of supervision of power plants. The society is entirely self-supporting, and the success is dependent upon the value of the return it makes to its members for their contributions and fees. In their report on the

* A bonus paid on each per cent of CO_2 produced over and above a certain fixed amount has been tried and worked out successfully in a number of cases.

several plants under their control, they give the thermal efficiency of a certain plant, with regular but untrained firemen as 66.6 per cent, and the thermal efficiency of same plant, with trained firemen, as 72.7 per cent. In the plant where these tests were made, this loss of 6.1 per cent in the fuel-efficiency represented a loss of $8.50, or $50 per week of 144 hours. In another test, the loss due to the use of untrained stokers rose to 16.1 per cent, the thermal efficiency being increased from 66.8 per cent to 82.9 per cent by the mere change of the firemen.

Nevertheless, we must recognize the present fact that in the United States today there is no specific and uniform instruction given to firemen, and hence the only other method of solving the problem seems to be by mechanical stokers. The types, construction and merits of the several different kinds of stokers will be discussed at length in a subsequent paper.

Steam Jets.

The steam jet is another type of apparatus used to aid hand-firing in smokeless combustion. These devices are applied either above or below the grates. When applied below, the effect is to soften the clinker and to increase the draft. This works fairly well where the fuel runs high in sulphur (or pyrites). When installed above the grate, the steam jet is essentially for the purpose of inducing a draft over the fires and for mixing the air with the distilled gases. The steam, of itself, furnishes no heat but rather requires heat for its decomposition.

Most of these devices are absolutely worthless and made only to sell. Occasionally one is found that is carefully worked out in its details, and when made so as to meet special conditions, with a mechanism for automatically adjusting the air supply to the volume of gas produced, and connected to a device for opening the damper immediately after a charge of coal is fired and graduating the damper afterwards, so as to decrease the air supply as the volume of gases decreases, such devices are of real service. The jet, however, has two very serious objections—large steam consumption, from 5 to 10 per cent being used, and noise. Neither of these objections can be overcome. Hence, against the saving made in the fuel bill by the steam-jet must be charged its steam consumption.

Down-Draft Furnaces.

Still another device for the prevention of smoke evolution is the down-draft furnace or grate, the best known type of which is the Hawley. The principle underlying the operation of this furnace is that the volatile hydrocarbons must pass through the green fuel and on

to an incandescent bed of coke before they reach the stack. The result is that the gases are more intimately intermingled with air at the proper temperature to support complete combustion.

These furnaces are provided with two sets of grates. The lower set is placed above the ash pit, as in the ordinary furnace. The upper grates are water tubes placed at a suitable height above the lower set, and inclined upward from front to rear with the tubes running longitudinally. The grate tubes are expanded into a header which in turn is connected to the water space or legs of the boiler, and so connected as to provide a circulation of water through the system.* Necessarily, this type of furnace has three sets of doors, one for each set of grates and one for the ash pit.

The operation is as follows:—

Coal is charged upon the upper grates, the air supply for which enters through these upper doors which are, therefore, generally open. A further supply of air is derived from the ash-pit doors, but has to pass through a bed of coke which heats it to a high temperature. Coke and partially burned combustible fall or drop from the upper grates onto the lower and thence to the ash pit, the lower grates receiving their entire supply of fuel in this way. The distilled hydrocarbons have to pass through the green fuel, where they are mixed with the air which entered through the charging doors, pass down to the lower set of grates (the space between the upper and lower sets constituting the combustion chamber) and meet the preheated air from the ash pit. The result is that the gases are mixed with sufficient air at a high temperature to maintain complete combustion.

This furnace, like others, gives good results, as far as smoke is concerned, when properly handled. It has the advantage in the small plant that it costs less to install than a stoker outfit. The furnace is usually hand-fired, though a gravity system can be installed. It gives its best results, economically, on a coking coal, though the makers recommend the use of the cheaper grades of fuel. It has the disadvantage of not being flexible over wide ranges of load and does not work well above rating. The initial cost of a furnace of this character is considerable, and sometimes it necessitates a new furnace and boiler-front construction. But the economy of operation is greater than with a steam jet. The cost of maintenance is, of course, largely absorbed by the water-tube grates, renewals, cleaning, etc., which in turn, are dependent upon the character of the water and the care in handling.

* Will add about 33 per cent heating surface.

A SUGGESTION FOR OVERLOADED BOILER PLANTS.

By Carl S. Dow.

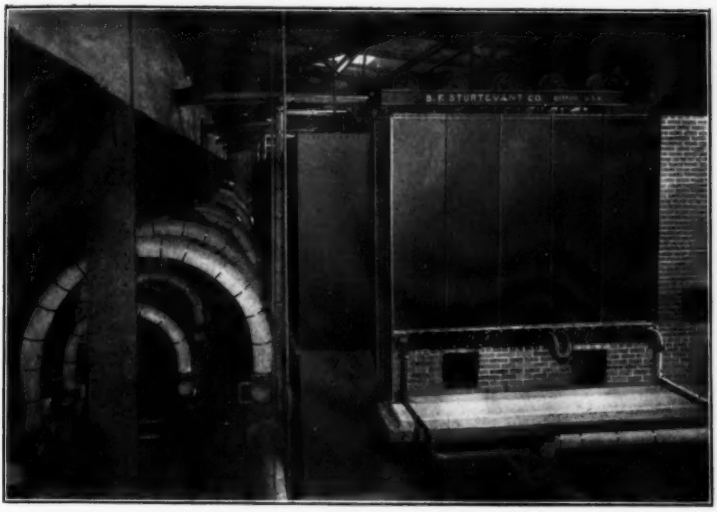
MANY a power plant for mill, factory, or small electric-light station, was built years ago with little expectation of greatly increased load; but from time to time there came demands for more power, and then for more power. The generating or power end was perhaps increased by adding another engine or generating set, or substituting a larger machine, and the boilers worked a little harder to make enough steam for the greater output of power.

With sufficient draft a steam boiler is rather flexible as regards capacity, and if conservatively rated will easily supply 50 or even 100 per cent above its normal capacity when pushed by a good fireman, provided highest economy is not essential. But when the horse power increases much above the normal, the efficiency decreases, because more coal must be burned per hour, and there is generated more gas which must pass off at higher velocity and at higher temperature. Usually a boiler is designed with proportions for evaporating 3 to 5 pounds of water per square foot of heating surface per hour. If compelled to evaporate greatly in excess of this, the velocity of the flue gas will be such that the heating surface will not have area enough to absorb the excess heat, and the gas will have a final temperature exceeding about 200 degrees above that of the steam, a figure which is considered good practice. A much higher temperature is an indication of low efficiency.

If the plant in question has grown to an extent that makes imperative still more power, the time must soon come when increased boiler capacity is necessary, for more steam cannot be made with a reasonable efficiency with the existing grate, fittings, and auxiliaries.

The Problem.

The management is confronted with a problem, the solution of which involves financial calculation as well as the exercise of good engineering judgment. The easiest solution seems to be the purchase of a new boiler; but if the operating engineer suggests an economizer, his suggestion will very likely receive much attention, especially if the addition of a boiler would mean expensive alterations in the already



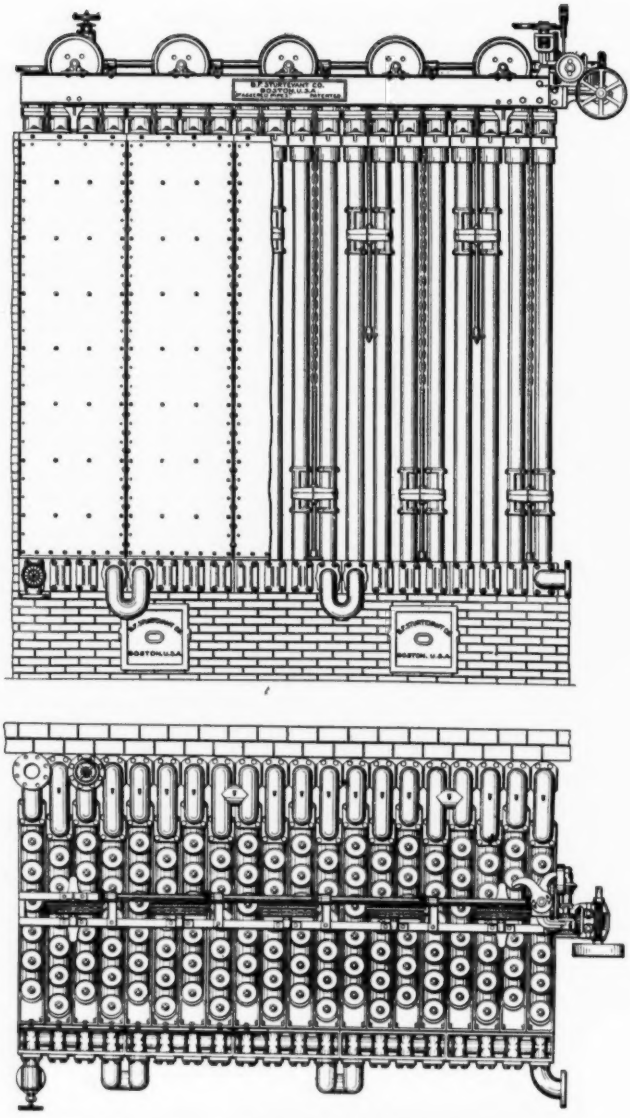
STURTEVANT ECONOMIZERS AT CHAMPION COATED-PAPER COMPANY'S PLANT, HAMILTON, OHIO.

crowded plant. The economizer can usually be supported on structural steel above the boilers, thus reducing the cost of changes.

The matter of labor also would have an important bearing. Conditions might be such that the fireroom force was only sufficient to care for the boilers installed, including the removal of the ashes. The adding of another boiler would mean extra labor expense, but the labor of operating the economizer would not require additional help.

The draft also may have a controlling influence in the matter. If the plant as originally designed had a chimney which provided for a moderate increase in boiler capacity, it would doubtless care for the overload which has already been necessary. Another boiler would put an extra load on the chimney, which, if designed properly at first, would not be able to carry off the larger weight and volume of gas. In other words, the addition of another boiler would mean re-building the chimney, the construction of a small one for the individual boiler, or a mechanical-draft fan as an auxiliary.

The economizer, on the other hand, would add nothing to the volume of gas, but would decrease it because an economizer cools the gas which decreases in volume upon decrease of temperature. The economizer would affect the intensity of draft for it would interpose a resistance of 0.3 to 0.4 inch of water. Also, cutting down the temperature would reduce the intensity of draft. In all probability, the



ELEVATION, SECTION, AND PLAN OF STURTEVANT ECONOMIZER.

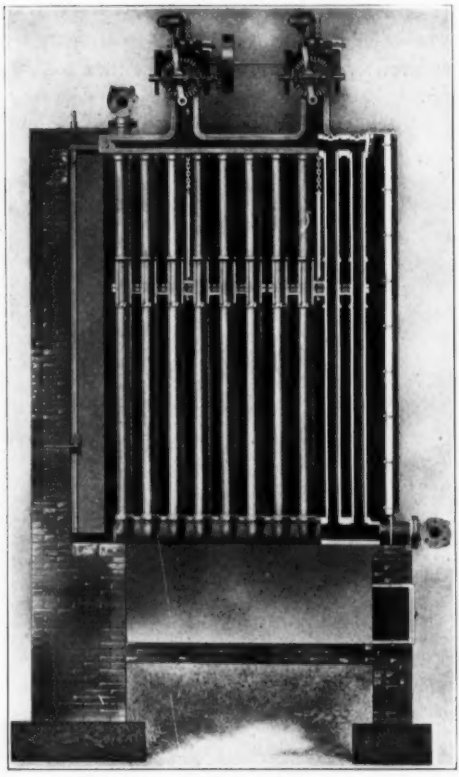
addition of either boiler or economizer would require auxiliary draft apparatus, and in absence of definite knowledge, and to eliminate the draft as the important feature, let us assume that in either case an under-grate fan is to be installed. This then would make unnecessary further consideration of draft in the expense, and would provide draft for hand-firing or any type of stoker.

GREEN ECONOMIZERS, MANHATTAN POWER STATION OF THE INTERBOROUGH RAPID TRANSIT CO., N. Y.

As to the financial proposition; first cost alone cannot be the controlling factor. The first cost and all the expenses for several years must be computed for both boiler and economizer, so that a comparison of the results will aid in deciding the question. Before making the calculation let us understand the economizer, for it is not as commonly used as boilers.

The Economizer.

An economizer consists of a large number of pipes so arranged and connected that water can flow from one end of the apparatus to the other. This is accomplished by connecting the pipes into headers, thus forming rows or sections having four to twelve pipes. The head-



GREEN ECONOMIZER. VERTICAL SECTION.

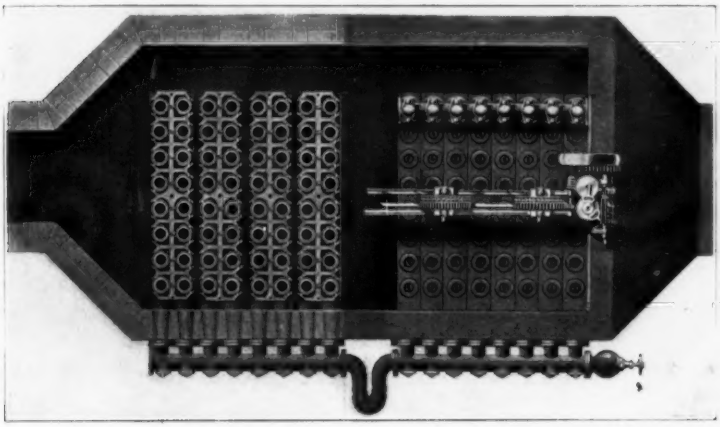
ers, both bottom and top, are connected to wall boxes at the bottom and manifolds at the top which extend at right-angles to the headers. Since the economizer is under the same pressure as the boilers, being between the pump and the boiler, all joints must be tight for pressures up to 150 to 300 pounds. The waste gas is conducted to the economizer, and naturally it carries much soot and dust, which would accumulate on the pipes if allowed to do so. As soot is a poor conductor of heat, the transmission would be impaired and therefore each pipe is provided with a scraper which is made to move continuously up and down so that the pipes will remain clean and readily transmit the heat to the water within. The economizer is enclosed in brick or in a sectional asbestos-steel casing so that the gas will flow among and between the pipes. The apparatus is provided with a relief valve for safety, and with blow-off valves for many of the impurities of the water are precipitated in the economizer.

The Plant.

Let us assume that the plant has six 250 horse-power boilers, and that the rated output of 1,500 boiler horse power is actually increased to 2,200. The overload is not excessive under most conditions, but the management does not think it best to push the boilers harder even though 200 to 250 horse power is needed, or will be needed in the near future. As far as steam is concerned, another 250 horse-power boiler

would do, or an economizer, for economizers often add 10 per cent or more to the capacity, and an economizer would supply an amount of heat equivalent to that necessary to evaporate 250 × 30 = 7,500 pounds of water.

Before taking up the relative expenses attending the installation and operation of a boiler or economizer, let us see how large an economizer can be put in and ascertain whether or not it will add sufficiently to the capacity.



GREEN ECONOMIZER. HORIZONTAL SECTION.

Since the plant has an output of 2,200 horse power, it will use about 2,200 × 4 = 8,800 pounds of coal per hour, and if we assume that 24 pounds of air are admitted per pound of coal, there will be 25 × 8,800 = 220,000 pounds of gas available for the economizer. The specific heat of escaping furnace gas is practically 0.23; therefore 220,000 × .23 = 50,600 B. t. u. per degree, will be contained in the gas, a considerable proportion of which can be transferred to the water. If we assume that the gas leaves the boilers at 650 degrees and that we can cool it to 450 degrees, theoretically the available heat will be 50,600 × (650 — 450) = 10,120,000 B. t. u. Those installing and operating economizers know that only about 75 to 80 per cent of the heat of the gas will be transmitted to the water, the remaining 20 to 25 per cent being lost by radiation, air leakage, etc. 10,120,000 × .75 = 7,590,000 = available B. t. u.

Again making assumptions as to apparatus: If the heater delivers the water to the economizer at 200 degrees and the steam pressure is 150 pounds, 1,025.5 B. t. u. will be required to evaporate one pound

of water, for 1,225.5 — 200 = 1,025.5 B. t. u. 1,225.5 is the total heat in the steam at 150-pounds gauge, measured above vacuum. If all the heat according to our calculation is transmitted to the water there will be enough to evaporate 7,590,000 ÷ 1,025.5 = 7,401 pounds of water, or the equivalent of 7,401 ÷ 32.5 = 228 horse power. This factor, 32.5, is the amount of water to be evaporated per boiler horse power when the pressure is 150 pounds and the feed temperature 200 degrees. As calculated, the economizer would add 228 boiler horse power; but since we assumed a low factor (.75), the horse power actually added would probably be nearer 250.

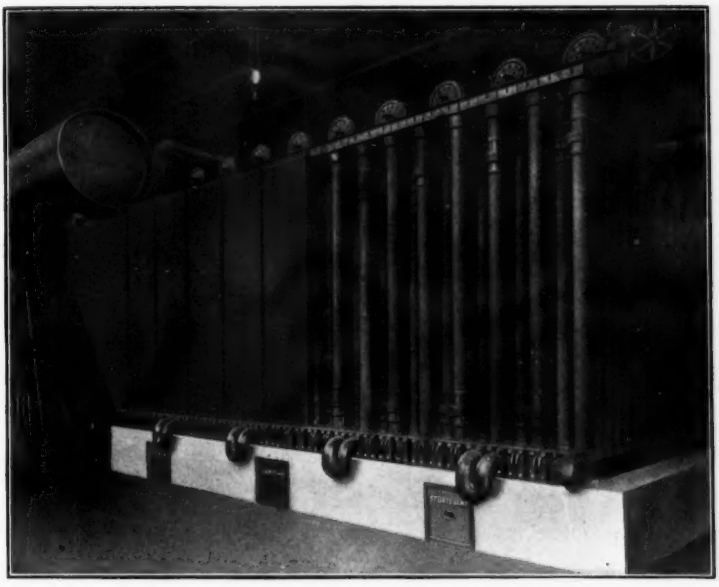
Now let us see to what temperature the entire amount of feed water will be raised by the economizer, assuming as before that it enters at 200 degrees, and that the economizer is large enough to transmit all the available heat.

The total boiler horse power will be 2,200 + 228 = 2,428 and therefore 32.5 × 2,428 = 78,910 pounds of water will be evaporated. Available heat ÷ pounds of water = temperature; or, 7,500,000 ÷ 78,910 = 96.

In other words, the economizer will heat all the feed water to 296 degrees. As the water enters at 200 degrees and leaves at 296 degrees, the mean temperature of the water will be (200 + 296) ÷ 2 = 248 degrees. The gas enters the economizer at 650 degrees and leaves at 450 degrees; therefore, the mean temperature of the gas will be (650 + 450) ÷ 2 = 550. The mean temperature difference will then be 550 — 248 = 302 degrees.

Experiment has shown that with a mean temperature difference of 300 degrees, about 3 B. t. u. are transmitted per square foot per degree difference; therefore 248 × 3 = 744 B. t. u. are transmitted per square foot and available heat ÷ transmission per square foot = area of heating surface; or, 7,590,000 ÷ 744 = 10,202 square feet. Since an economizer measures practically 12.5 square feet of heating surface per pipe, the economizer in question should be made up of 10,202 ÷ 12.5 = 816 pipes.

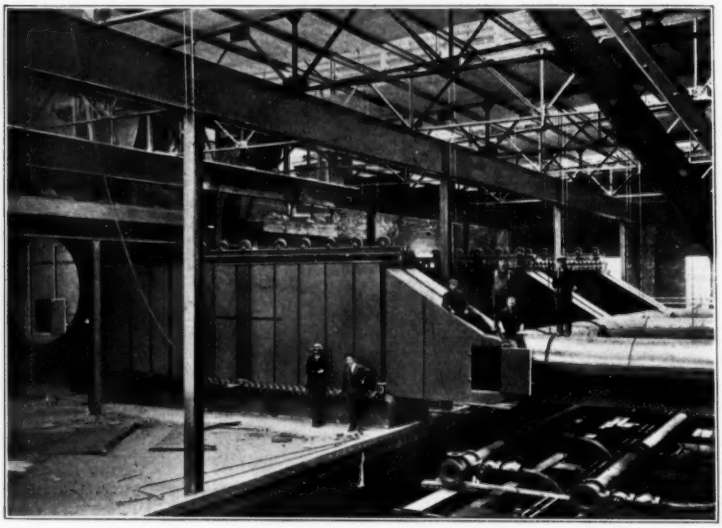
Let us check these figures with a few known facts. Usually, the heating surface of an economizer is 4 to 5 square feet per horse power; this one has 10,202 ÷ 2,200 = 4.63 square feet. If the economizer is proportioned as is customary, a drop of 2 degrees in the temperature of the gas results in an increase in 1 degree in the feed water; in this case the gas drops 200 degrees while the feed water rises 96 degrees, but as we assumed only 75 per cent of the heat to be transferred to the water, the actual rise might be fully 100 degrees.



STURTEVANT ECONOMIZER AT CLEVELAND CLIFFS IRON COMPANY'S PLANT, ISHPEMING, MICH.

The question to be decided is: Will it be more economical to put in a 250 horse-power boiler, or an economizer having 816 pipes? In first cost, the boiler will of course be much cheaper, for an average price per boiler horse power is $10, making the cost of the boiler $2,500, while the economizer will probably cost at least $10 per pipe, or $8,160. But this is only the beginning; let us see what the difference will be when fuel, depreciation, taxes, operating expenses, etc. are taken into account.

Charles T. Main states that with good water and care, the life of a boiler running 12 hours per day should be about 20 years, or the depreciation 5 per cent. a year. The life of an economizer, according to this engineer, varies with the initial temperature of the entering water from about 10 years up to 40. Let us assume a figure between these limits and say that the economizer also will last 20 years, making the depreciation the same as that of the boiler, 5 per cent. The matter of depreciation must be in the nature of an approximation, for depreciation is not always separated from repair expense, and a part of the depreciation may appear as repairs, supplies, etc. It should, however, be considered as a sinking fund, which is the sum



GREEN ECONOMIZERS, POWER PLANT OF THE HOLLINGSWORTH & WHITNEY CO.

laid aside each year to purchase new apparatus to take the place of that worn out or rendered less valuable because of the introduction of new designs.

The question of repairs or maintenance is another that must be an approximation. Maintenance expense is the cost of keeping the apparatus in running order, and should be separate from cost of attendance. It usually includes replacement of worn-out parts. In the case of the boiler, the maintenance expense would probably be higher for the water-tube than for the fire-tube type. Probably 1 per cent. per year of the initial cost would be sufficient. With the economizer. 1 per cent will be ample for maintenance and repairs for there are few moving parts and the temperatures are not nearly as great as those in the boiler.

We may allow 2 per cent of the original cost to cover insurance and taxes, items which vary slightly with locality. The difficulty of obtaining money has some influence upon the amount to be allowed for interest on the investment, but 5 per cent will be a good average.

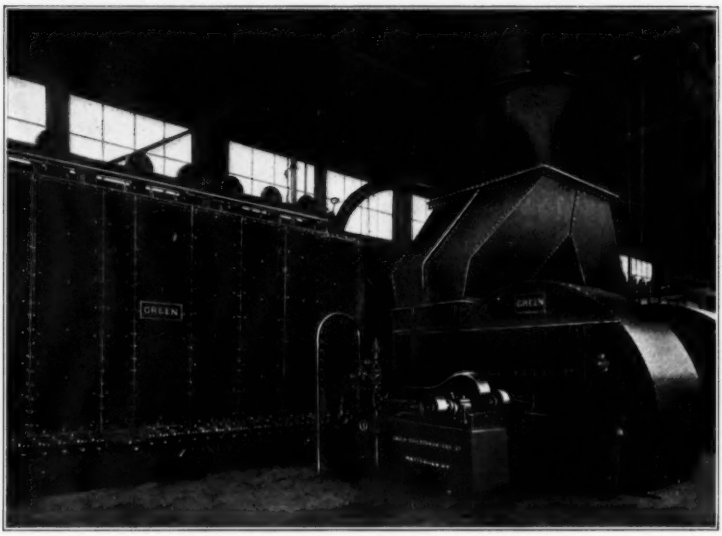
The only important item left is the operating expense, and this must show greatly to the advantage of the economizer, for the heat units for the economizer are obtained from waste gas, while with the boiler coal must be continuously fed to the furnace. The operat-

ing expense of an economizer is only the cost of the power necessary for the driving of scrapers. Since the economizer will probably furnish 250 horse power, the power for the scrapers might be reckoned per horse power, but it is more usual to state the power required per pipe, or the number of pipes that can be kept clean with one horse power. Experiment shows that with an economizer of this size 1 horse power will keep the scraper going on about 275 pipes. Therefore the 816 pipes will require 3 horse power, but to insure power enough to prevent sticking, 5 horse power would be put in. This will be $5 \div 2{,}450 = .002$, or 0.2 per cent; the cost of this power is so small that it may be neglected.

The labor expense of operating both boiler and economizer is to be neglected as already stated, for it was assumed that the existing fireroom labor would attend to either.

As to the coal. In absence of knowledge as to locality, we must make assumptions. Coal may be considered to cost $4 per ton at the boilers, and it is reasonable to assume that the boilers will require $3\frac{1}{2}$ pounds per boiler horse power, and therefore $250 \times 3\frac{1}{2} \times 10 = 8{,}750$ pounds per day, or 3.9 tons per day, or $3.9 \times 300 = 1{,}170$ tons per year, which will cost $4,680.

STURTEVANT ECONOMIZERS, J. R. BOOTH FACTORIES.



GREEN ECONOMIZERS INSTALLED AT HOBOKEN, N. J., FOR THE D. L. & W. R. R.

Collecting these items we have for the boiler:

Interest, 5 per cent of $2,500	$125
Depreciation, 5 per cent of $2,500	125
Maintenance, 1 per cent of $2,500	25
Insurance and taxes, 2 per cent	50
	$325

For 20 years the expense will be $20 \times 325 = \$6,500 + \$2,500 = \$9,000$. To this must be added the fuel bill, or $\$9,000 + (20 \times 4680) = \$102,600$.

Economizer cost for one year:

Interest, 5 per cent of $8,160	$408.00
Depreciation, 5 per cent of $8,160	408.00
Maintenance, 1 per cent of $8,160	81.60
Insurance and taxes, 2 per cent	163.20
	$1,060.80

For 20 years the expense will be $20 \times \$1,060.80 + \$8,160 = \$29,376$. These figures show that there would be a net saving of $\$102,600 - \$29,375 = \$73,224$, by installing the economizer, or an average of $3,661.20 per year.

Expressed another way: The cost of a boiler horse power per year under the above conditions and with the given assumptions would be $\$102,600 \div (20 \times 250) = \$20.52$. With the economizer, assuming it to be the equivalent of 228 boiler horse power, the cost per year would be $\$29,376 \div (20 \times 228) = \$6.44$, or a saving by using an economizer of $\$20.52 - 6.44 = \$14.08$, per horse power per year.

EDITORIAL COMMENT

Safety in Mining.

THE institutions described by Mr. Stoek in our leading article in this month are an interesting evidence of changing attitude toward industrial relations—an example of intelligent provision by employers for the better welfare of their employees. Under the older order there was little attempt to take any position in this matter between the extremes of complete indifference on the one hand, leading to callousness and brutality, or patronizing paternalism on the other hand, leading to evils of its own almost as bad economically if less repugnant morally. The newer idea is akin to the principle of "helping men to help themselves," which has been found so useful elsewhere.

A marked extension of the same motive appears in the Government work, investigational and educational, in the use of mine explosives. An authoritative report on this subject by the experts of the United States Government will appear in our July issue. To State authorities and to the officers of the mining companies, it will afford a body of knowledge useful for conservation of life and property. The more progressive will seize upon the information eagerly, irrespective and in advance of any statutory requirement.

A Study of Labor Conditions.

VERY interesting data and conclusions on matters closely related to those referred to above are embodied in Dr. Victor S. Clark's monograph on "Women and Child Wage Earners in Great Britain," just published by the Bureau of Labor of the United States Department of Commerce and Industry. The author refers to the common impression (supported by his observation) that conditions surrounding this class of workers in Great Britain are often very bad; but he avers that there are no greater depths than can be found in some parts of America. And, indeed, his summary of the character and effect of recent legislation would seem to show that Great Britain now offers models that some of the States must rise to reach.

The law, administered by 200 factory inspectors, assisted by the local authorities and by 2,000 certifying surgeons, is concerned chiefly with hours of labor and with employment in dangerous trades, though some recent enactments seek to improve the home environment of the laborers. Children are not allowed to work under 12 years of age, and then only half the time, in factories or above ground at mines. The other half of the thirteenth year must be given to school. Full-time work, under certain restrictions, is allowed to children above 13 years of age. "Young Persons" from 14 to 17 may work 12 hours daily by day only, and to a total of only 55½ hours a week in textile factories or 60 hours a week in other works. Overtime is practically prohibited to children or young persons, and is permitted only to a limited extent to women, whose work generally is subject to the same restrictions as that of young persons.

Dangerous occupations are under special regulation by the Home Secretary as well as by specific laws. Home work is also under regulation, and excessive fines or charges for extras are prohibited. Piece workers must be given an itemized statement by the employers.

The effect of the restrictions is reported to be a material decrease in the number of female and juvenile workers,

partly for the simple economic reason that employers no longer find it so profitable as it was when unrestricted, but partly through change in public sentiment, and through progressive improvement in wages by which working people are better able to get along without the earnings of their children. With decreased employment of married women there seems to be a betterment of certain important social conditions, notably higher standards of family comfort, more careful provision of wholesome diet, increased school attendance of the children, and lower infant mortality. All these factors manifestly influence, immediately and powerfully, the efficiency of the workers going out from the home; and the most impressive deduction from Dr. Clark's study is that "one of the first ways to improve the condition of wage earners of the weaker industrial classes is to increase their efficiency." With full recognition of the excellent motive and effect of direct industrial regulation, he lays stress upon the necessity for "broader and more generous remedies"—meaning thereby influences permeating the life of the workman outside of his place and hours of labor. The most important of these influences suggested by Dr. Clark are higher efficiency, higher earnings, and a more intelligent distribution of home expenditures. This is in accord with the doctrine of welfare work to which we have always given our earnest assent; that is, that elaborate institutions for miscellaneous instruction, recreation, social diversion, and incidental publicity, are a false graft upon industrial development, and seldom result really well for the maintenance of mutual regard between employer and employee; and that while the employer should remove conditions of discomfort and assure surroundings characterized by hygiene and decency and stimulative of self-respect, it is generally expedient to limit contractual relations to that mark and then to provide a mode and scale of payment enabling the employee to earn the largest wages possible to his capacity.

Dr. Clark refers to Great Britain's apparent disposition to invest legislation with a new function—that of "economic readjustment to make possible higher earnings." The immediate effort in this direction seems to be the establishment of a minimum wage. It is difficult to see anything hopeful or expedient in such an attempt. If the functions of government are ever effectively exercised for the promotion of efficiency, it will not be through artificial regulation of the wages to be paid or to be accepted as between third parties, but through exercising some of its natural and ordinary offices so as to accomplish the same result in a natural and ordinary way.

Such a mode was suggested by Mr. Emerson in this Magazine last March, in the concluding article of his series on Efficiency. His proposal was that when individuals and corporations are in a period of lull, the Government should come into the market with long matured plans for unhurried improvement; that employment in national works, reclamation of arid lands, harbor dredging, canals, highways, should always be open to the otherwise unemployed at a minimum wage, thus doing away forever with the disgrace of "bread lines." Such work, even in moderate quantity, would automatically regulate the scale of wages in industry.

A wiser and saner socialism, this, than any effort to prescribe terms of contract between individuals — ignoring or attempting to override the laws of supply and demand, of competition, and those fundamental principles of economics which are inevitable, and certain to visit their own punishment inevitably upon all violators.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

PRIME MOVERS.

A DISCUSSION OF THE ECONOMICS OF ELECTRIC POWER GENERATION.

Charles P. Steinmetz—American Institute of Electrical Engineers.

A PAPER on prime movers, with special reference to their suitability to the various economic and other requirements of electric service, read by Dr. Charles P. Steinmetz at the February meeting of the American Institute of Electrical Engineers and published in the February number of the *Proceedings*, contains one of the most lucid discussions of the broad general principles of the economics of electric power generation which have come to our notice. This part of Dr. Steinmetz's paper is reproduced in rather full abstract below; a theoretical discussion of thermodynamic prime movers, with which the paper is concluded, is beyond the scope of this review.

"To become available for conversion into electric power, the energy found in nature must first be converted into mechanical rotation by some form of prime mover. The engineering characteristics of these apparatus may be classed under two main groups, those referring to economy and reliability, respectively. In both, the electric machine, whether generator or motor, ranges very high: its efficiency is virtually unity; its size, first cost, and maintenance small; its reliability great. In the cost of electric power the electric machine plays only a subordinate part; the essential element in determining the cost and the reliability of electric power is the prime mover; that is, the intermediary step between nature's stores of energy and the dynamo shaft.

"The cost of electric power consists of three parts: (1) the fixed cost or permanent cost; that is, the cost depending on the size of the station, but not on the amount of power supplied by it; (2) the proportionate cost; that is, cost proportional to the amount of power delivered; and (3) the reliability insurance; that is, the additional cost required to assure the desired reliability of service."

The first of the items under fixed cost, the interest on the investment in the plant, varies very greatly with the form of the available energy. On account of the hydraulic development required, it is frequently very large in water-power plants. It also depends on the prevailing rate of interest, on the ease with which the capital for development can be obtained, and on local conditions—whether a market is waiting for the power or is within easy reach, or whether a market has first to be created. The item of depreciation is different for different parts of the line; it is very low, for instance, for buildings and for line copper, and very high for such apparatus as railway motors. In considering depreciation, it must be recognized that the useful life of the apparatus may be much shorter than the total life, and that the ratio of the useful life to the total life varies with different apparatus. The useful life of apparatus is ended when the cost of the difference in economy, properly capitalized, exceeds the cost of reconstruction of the plant. In electrical plants this condition may arise through

advances in the art of design, through an increase in the market which makes the original units too small, the space-economy too low, or the voltage too low, for economy, or through other changes which make the old plant uneconomical. When the useful life is ended, the old apparatus should be thrown out with whatever salvage is feasible, either by use as reserve, to take care of peak loads, or to be operated elsewhere when it is displaced on account of considerations of space economy. Besides interest and depreciation, a certain part of the operating expense must be included under fixed cost, namely, that part which does not depend on the use of the plant.

Under proportionate cost are included the cost of energy and accessories to its conversion, fuel, oil, etc.; the cost of labor and attendance, including that part of supervision which varies with the power utilized; and the cost of maintenance and depreciation of the plant, as far as they depend on the use of the apparatus, commutator repairs, etc.

Reliability insurance includes the overload capacity of apparatus in power, voltage, etc., provided to take care of emergencies; duplication of parts of the plant, as reserve units, duplication of exciter plant, of lines, feeders, etc., and additional plant, as steam reserve with water-power plants, storage-battery reserve, tie lines with other systems, etc.

Some items of the cost of power may belong partly in one, partly in the other class; depending on local conditions the cost of developing water storage, for instance, would belong under fixed cost, if the power capacity of the plant depended on it, and under reliability insurance if provided to guard against failure of the power in unusually dry seasons. Reliability insurance consists in part of the character of fixed cost, and in part of the character of proportionate cost; but in these days when the lay public is interested in the cost of electric power, and is comparing plants which may be very different in regard to reliability of service, it appears desirable to recognize the insurance of continuity of service as a separate part of the cost of electric power. The great difficulty in discussing reliability of service is the absence of any established standard. A classification of electric power supply regarding its reliability may be made on the basis of the number of shutdowns per year, and four classes of shutdowns may be distinguished, by the time of their duration: (1) less than one second, that is, less than the time required to throw synchronous apparatus out of step; (2) less than 20 minutes, that is, the time in which synchronous apparatus in a well organized plant can be put back into service; (3) less than three hours, that is, the time sufficient to start anew a steam plant, repair or renew such apparatus as transformers, repair lines, etc.; and (4) more than three hours, or a complete breakdown of the system. In estimating reliability a shutdown of part of a system may be considered as a part of a shutdown, and voltage variations beyond fixed limits may be treated in the same way. About the best system of classification which can be expected at present is as follows:

1. First class service: (1) less than 4 per year; (2) less than 1 per year; (3) and (4) absent.

2. Good service: (1) less than 12 per year; (2) less than 4 per year; (3) less than 1 per year; (4) absent.

3. Second class service: (1) less than 52 per year; (2) less than 12 per year; (3) less than 4 per year; (4) less than 1 per year.

4. Third class service: (2) less than 52 per year; (3) less than 12 per year; (4) less than 4 per year.

5. Unsatisfactory service, suitable only as auxiliary power, etc.

Most of the features of prime movers pertain either to economy or to reliability. Economy may be considered under the heads of power economy or efficiency, space economy, investment economy, labor economy, and maintenance, repair and depreciation. With a thermodynamic engine the total efficiency is the product of mechanical efficiency, thermodynamic efficiency and producer efficiency. The thermodynamic efficiency, the ratio of the available energy in the engine to the total heat energy supplied to it, depends essentially on the temperature range utilized by the engine, with which it increases, and to a lesser degree on the

thermodynamic cycle used. The mechanical efficiency, the ratio of the mechanical output at the engine shaft to the available energy in the engine, depends on the size per kilowatt output of the cylinder volume, on the temperature range, pressures, momentum of the moving parts, their velocity and the nature of the velocity, whether reciprocating or rotating, etc. In general it increases with increasing size and mass per kilowatt, with increasing speed, and with increasing temperature and pressure differences. It thereby depends largely on the available energy per unit volume and per unit weight of the working fluid. The producer efficiency is the ratio of the total energy of combustion of the fuel to the heat energy supplied to the engine; its consideration opens a field too wide to be discussed in the present paper. As the cost of the energy is only a part of the proportionate cost of power, the importance of the efficiency varies with the proportion which this part of the cost bears to the total cost; it depends therefore, upon numerous considerations, size of plant, load factor, etc. In general, high engine efficiency increases in importance with increasing size of plant, and with increasing load factor, and in large plants becomes the most important factor.

Space economy depends essentially on the engineering skill and judgment in the design of the plant, and on the type of the prime mover. It affects the fixed cost of power and varies greatly in importance, according to local conditions. Investment economy depends largely on the available market and the desired quality of the power. It affects the choice of the prime mover; for with an assured market, requiring high grade of service, the large investment of a first class modern plant with the best type of prime movers and ample reserve is most economical; in other situations, for instance in the case of auxiliary plants, good judgment may suggest cheaper and correspondingly less efficient apparatus.

With a high price and a poor quality of skilled labor, prime movers which require a higher grade of attendance become less economical than less efficient prime movers which can be operated by unskilled labor or require very little skilled labor. In the United States particularly the reduction of the amount of high-grade skilled labor is economically necessary, and this fact has influenced to a considerable extent the development of the industry. Designers of electrical apparatus and other machinery have been forced to devote their attention chiefly to making the apparatus as "fool-proof" as possible, even if efficiency and other characteristics have to be sacrificed to some extent.

Maintenance, repair and depreciation depend largely on the type of prime mover, and in thermodynamic engines on the cycle used. Greater mechanical and temperature stresses, in general, other things being equal, tend to greater maintenance and repair cost and more rapid depreciation. Thus this item is to some extent proportional to the mechanical efficiency, and inversely proportional to the thermodynamic efficiency of the engine cycle. The economic item of depreciation depends, however, not only on the wear of the apparatus but also on the limitation of its useful life. In this respect it must be kept in view that with apparatus which is in a state of rapid development, as the steam turbine, the useful life should be expected to be shorter than with apparatus in a field in which no great development occurs.

It will be seen that in the economic characteristics of thermodynamic prime movers in general, efficiency and the other features are to some extent mutually conflicting. Engineering judgment must therefore decide on the relative weights of the different economic factors which enter into the choice of the prime mover in each individual case.

Features which are important for the reliability of the plant and hence for continuity of service are: (1) the absence or presence of external influences beyond the control of the operating force, as meteorological effects, etc.; (2) the design of the plant, particularly the arrangement of prime movers and electrical apparatus, which should be carefully laid out to afford the greatest safety of operation before the plant is constructed and before the buildings are designed; (3) the probable frequency of

shutdown of the prime mover, and the liability of involving other machines by it, and the number of other units and reserve plants available, a factor related to the economic item of maintenance repair and depreciation; and (4) rapidity of starting of apparatus and getting them into service, to cope with emergencies as a shutdown of the system or a part of it, an accident to one or several units, etc., or even an unexpectedly rapid increase of load, and rapidity of reaction to changes of load. These features depend to a considerable extent on the type of prime movers and other apparatus, but to a still greater extent on the preparedness for such emergencies and on the organization of the operating force.

In the concluding part of his paper, Dr. Steinmetz discusses the characteristic features of the available types of prime movers, with regard to their suitability for the various economic and other requirements of electric service. Hydraulic prime movers he dismisses with a brief outline of their more prominent characteristics. Thermodynamic prime movers, however, he discusses at considerable length, his review embracing the steam engine, condensing and non-condensing, with and without superheat; the steam turbine, condensing and non-condensing, with and without superheat; the gas engine, using the available fuel directly, as natural gas, blast-furnace gas or liquid fuel; and the gas engine, with producer plant converting solid fuel into gas.

THE PROBLEM OF EFFICIENCY IN ILLUMINATION.

A CLASSIFICATION AND EXAMINATION OF THE FACTORS UPON WHICH IT DEPENDS.

Arthur J. Sweet—The Electric Journal.

IN the comparatively new science of illuminating engineering, as in nearly all other branches of engineering work, the problem of efficiency plays an important part. It is, in fact, of even more marked importance in illumination than in other fields. In the application, for instance, of an electric motor, efficiency is usually a consideration secondary to reliability; in air brake and signal systems, it is entirely subordinated to the latter. The choice of a steam engine, under certain conditions of fuel supply and cost, may sometimes be governed by considerations of first cost rather than of efficiency of operation. In illumination, however, efficiency of operation is a consideration so paramount that it may rightly be called *the* problem of illumination. The physical and physiological factors upon which efficiency of illumination depends are given a very simple and comprehensive exposition in a paper by Mr. Arthur J. Sweet in *The Electric Journal* for March. The abstract given below will form a useful introduction to an article on the illumination of industrial plants to appear in our July number.

Mr. Sweet first disposes of two common objections to the view that the problem of illumination is primarily one of efficiency. The first is the question of the relative importance of efficiency and the useful life of the illuminating apparatus. Curves are given, showing the relation between the renewal cost of the lamp to the power consumption cost at different costs of power per kilowatt-hour, for a 16 candle-power, 3.1 watts per candle, 110-volt carbon-filament lamp. They show that within the range of cost at which electrical energy is commonly available to the user of light—8 to 15 cents per kilowatt-hour—the renewal cost is almost negligible as compared with the cost of power. In the case of the gas mantle, the Nernst lamp, the mercury-vapor lamp, or any of the various forms of arc lamp in commercial use, a similar relation exists; the useful life is of minor importance as compared with efficiency. The second objection has to do with the artistic quality of illumination, which is sometimes asserted to be frequently of more importance than efficiency. Artistic merit and efficiency are not antagonistic nor even independent principles; in illumination, art and efficiency go hand in hand. Not all so-called artistic installations are efficient; but the truly efficient installation is almost invariably artistic.

The general laws upon which the efficiency of illumination depends are the fundamental laws of illuminating engineering. A discussion of the factors which determine efficiency, therefore, must proceed from a recognition and classification of the laws according to which these factors act. At the outset it is necessary to have a clear conception of what is meant by efficiency in illuminating engineering. In the older engineering sciences, efficiency is the useful energy out-put divided by the energy input, expressed as a percentage; and in most engineering work the end sought is the transformation of one purely physical form of energy into another purely physical form. In illumination, however, the end sought is a physiological process, sight; and as yet no unit has been found to establish a relation between energy and the physiological sensation called clear vision. But though the illuminating engineer has no *unit* of efficiency, the term efficiency can be used and the distinctions of higher and lower efficiency can be drawn. In illumination there is for any installation a fairly definite condition known as "good illumination." For any given plane of reference, or for any combination of such planes, the relation of the efficiencies of two different schemes of illumination will be the inverse relation of the energy in-put required to produce "good illumination" in each case. The problem of the illuminating engineer is to determine the laws on which efficiency depends and so to apply these laws in the utilization of energy as to accomplish the greatest amount of useful work per unit of energy, measured in terms of visual perception, even though he cannot express in absolute terms the results attained.

In the term "efficiency of illumination" is included the combined effect of three different kinds of efficiency; first, the efficiency of visual perception, that is, the efficiency with which the eye receives light energy and transforms it into visual perception; second, the efficiency of light distribution, the relation between total light energy generated and light energy useful in producing desired conditions for visual perception; and third, the efficiency of the light source, that is, the efficiency with which chemical or electrical energy is transformed into light energy. All three are of importance; it has been the error of the past to lay all the emphasis on the last.

Efficiency of visual perception depends upon three conditions, the intrinsic brilliancy of the light source and of the surrounding light-reflecting objects, the color of the light, and the intensity and steadiness of the light. "The eye adjusts itself to various degrees of light intensity by the automatic expansion or contraction of the pupil or opening in the iris diaphragm through which light is admitted to the eye. Now the light which is active in causing a greater or less contraction of the pupil is not merely the light which comes from the centre of the field of vision, but the light which comes from the entire field of vision. The light which is active in causing visual perception, however, comes under normal conditions entirely from the central portion of the field of vision. The same amount of light, therefore, falling upon and reflected from the given visualized object may produce very different degrees of illumination due to changes in the size of the pupil, such changes resulting from differences in the intrinsic brilliancy of the outlying portions of the field of vision." For example, the introduction of a second light source into the field of vision of a reader sitting below and with his back to a light, screening the printed page so that it gets no light from the new source, causes a contraction of the pupils which then admit to the retinae less light from the printed page; the sensation of clear vision is more or less destroyed, though the photometric intensity of the light on the printed page may be the same in both cases. White or brightly lighted walls may have an effect similar to that of a brilliant light source. The decrease in efficiency from causes such as these is recognized in the rules of illuminating practice, that light colored walls or ceilings should not be illuminated too brilliantly and that when a brilliant light source is placed so that it may come within the field of vision, its intrinsic brilliancy should be reduced by a diffusing shade.

The color of the light which should be chosen depends upon the color of the objects to be illuminated, since with the same intensity when measured in foot-candles, lights of different colors give appreciably different illumination values. For objects of a great variety of color, the best light has the quality of summer day-light; for the illumination of black and white effects, a modified white light or a green light. As to the intensity, it is a common fallacy that the more the light the better the illumination. As a matter of fact, for any given light intensity in the outer portions of the field of vision there is a corresponding definite intensity of light for the central portions which will give the best conditions for visual perception. Greater intensities, or a flickering, unsteady light, will produce gradual or rapid fatigue of the eye functions.

Efficiency of light distribution depends upon two very important factors, the distribution of the light which emanates from the illuminating unit, and the size of the unit and the location of centers of light distribution. When light falls upon any of the surfaces with which we are commonly surrounded, a very considerable percentage of it is absorbed, while the rest is reflected, the absorption varying from 80 per cent on white surfaces to 10 per cent on dark brown. If light is to be used efficiently, it must not undergo many reflections, losing in each as it does under average conditions say 70 per cent. in intensity. Ideal efficiency of distribution is obtained only when all the rays emitted by the illuminating unit proceed directly and in proper proportion to the various surfaces to be illuminated, whence they are reflected to the receiving eye. These principles are well known, but there are few installations in which the power consumption required could not be halved, or the efficiency doubled, by utilization of the light now wasted through absorption.

None of the light sources of themselves gives efficient distribution, but, fortunately, it can be obtained by the use of reflecting or refracting shades or globes. Of these, prismatic glassware is much superior to all others, particularly when a strong concentration is wanted in one direction and at the same time a small amount of light in all other directions. Suitably shaped green-enameled or opal glassware gives satisfactory results for broad downward distribution of light; the etched glass shades so frequently used are inefficient. When large areas are to be illuminated from a few light sources, excellent distribution can be obtained by the use of sand-blasted or opal globes with flat conical reflectors mounted above the lights. Problems of light distribution, however, should be entrusted only to a fully qualified illuminating engineer.

As to the size of the illuminating unit and the location of distribution centers, each installation is so much a particular problem that only a few rules of general application can be laid down. The centers of light distribution should be located over the points on which a relatively high intensity of light is desired. Their number varies with the particular problem, but it should be kept as low as possible; more artistic results and better efficiency are obtained when the light comes from clearly marked sources. Several smaller illuminating units, preferably three, four or five, adjacently located at the same center of distribution give more efficient effects than a single larger unit. An illuminating unit should not be located on a wall bracket or closely adjacent to a wall. If wall brackets are insisted upon for their supposed artistic effect, a small light source surrounded by a relatively large diffusing globe should be used. The application of these rules to residence lighting will demonstrate the efficiency of small light sources; in fact, cases are very unusual where light sources of more than 20 mean spherical candle power can be used without sacrifice of efficiency. Light sources of from 8 to 10 candle power have the largest application.

The efficiency of the light source depends primarily upon a single factor, the temperature to which the incandescent, light-giving body is raised. As the temperature rises, more waves of wave length short enough to be capable of stimulating the optic nerve are radiated in proportion to the total amount of radiant energy; hence the efficiency of the

TABLE SHOWING COMPARATIVE EFFICIENCIES OF VARIOUS ELECTRIC LAMPS.

Kind of Lamp.	Mean Spherical Candle-Power.	Watts per Candle.	Amount of Light per Kw-hr.
Common 56 watt carbon filament incandescent lamp rated at 3.5 watts per candle, 16 horizontal c-p	13.2	4.24	236 c-p. hrs.
Common 50 watt carbon filament incandescent lamp rated at 3.1 watts per candle, 16 horizontal c-p	13.2	3.78	264 " "
3-glower 264 watt Nernst lamp	81.0	3.26	307 " "
High-efficiency Gem 125 watt graphitized carbon filament lamp of 50 horizontal c-p	40.7	3.07	326 " "
44 watt tantalum lamp, 22 rated horizontal c-p	16.0	2.75	364 " "
Direct-current 5.1 ampere enclosed arc on 110 volt circuit, 0.5 inch carbons	213.	2.63	380 " "
Alternating-current enclosed 5.7 amp. arc taking 388 watts on 110 volt circuit, 0.5 inch carbons	152.	2.55	392 " "
Tungsten 60 watt, 1.25 watts per candle, 110 v. lamp	37.0	1.62	641 " "
Luminous 8 amp. arc, 440 watts, 2 in series on 110 volt circuit	1020.	0.431	2320 " "

light source increases with the temperature. "Every body or material, however, has its own fairly well marked limiting temperature beyond which the structure of the body rapidly deteriorates. Carbon, for instance, when heated in vacuum, throws off minute particles very rapidly at temperatures above 1,800 degrees C. This, therefore, is the temperature which limits the efficiency of the carbon incandescent lamp. Fortunately, in the case of both gas and incandescent lamp light sources, materials have been found which will withstand high temperatures without rapid deterioration. The gas mantle is too well known to need comment, but at its introduction it marked a tremendous advance in efficiency of light sources. Now a still greater advance has been made by the development of methods of preparation of various metals, of which tungsten stands first, for use as the filament of the incandescent lamp. Tungsten may be raised in vacuum to a temperature of at least 2,300 degrees C. without the occurrence of rapid deterioration. This increase in temperature from 1,800 to 2,300 degrees C. represents an increase in efficiency of 250 per cent." In the table given above the comparative efficiency of the tungsten lamp is shown.

THE TRANSANDINE RAILWAY.

A REVIEW OF THE HISTORY OF THE PROJECT AND RECENT PROGRESS IN CONSTRUCTION.

Bulletin of the International Bureau of American Republics.

AFTER a lapse of nearly fifty years since the establishment of direct rail communication between Buenos Aires and Valparaiso was first proposed, the Transandine Railway is now rapidly nearing completion and will be opened for through passenger and freight service not later than the spring of 1911. An interesting outline of the history of the project in the March *Bulletin* of the International Bureau of American Republics, from which the information contained in this review is taken, reports that the heaviest single portion of the work, the piercing of the Cumbre or Uspallata Pass by a tunnel 9,941 feet in length, has now progressed so far that a penetration on the Chilean side of 2,848 feet, and on the Argentine side of 1,791 feet, has already been accomplished, leaving little more than one-half the total distance still to be bored. During 1908 the second section on the Chilean side was opened to Portillo, 11 1-2 miles nearer the Argentine frontier. Including the short stage haul over the Pass, the journey from Buenos Aires to Valparaiso is now made in about 38 hours. The gross traffic receipts last year were $291,765, an increase of 35 per cent over the preceding year; the number of passengers carried increased 46,145, to 300,145.

What is generally known as the Transandine Railway forms the connecting link between two other lines, the Buenos Aires and Pacific and the Argentine Great Western, the whole system between Buenos Aires and Valparaiso being 888 miles long. The line traverses the extensive wheat fields of the Argentine pampas, the thriving vineyards and orchards of western Argentina, and, after crossing the Andes, the fertile valleys of Chile. The road when completed will be of the greatest practical

utility. Ultimately the time required for the journey between Buenos Aires and Valparaiso will be reduced to 29 hours; transportation by steamer, *via* the Strait of Magellan, now occupies ten days. The improvement of facilities for overland domestic communication, however, is not the greatest benefit which the opening of the railway will confer on Chile and Argentina. The improvement of their foreign relations is of far greater importance.

The project has had an interesting history. It had its inception as early as 1860 when William Wheelwright read before the Royal Geographical Society a paper showing the practicability of a transandean railway from Rosario, Argentina, 189 miles up the Parana River from Buenos Aires, over the pass of San Francisco to Caldera, Chile. Thirteen years later, in 1873, the first practical steps for connecting Buenos Aires and Valparaiso were taken when the Clark brothers, John and Matthew, obtained a concession from the Argentine government for the construction of a railway from Buenos Aires across the Republic as far as the Chilean frontier. The route to be selected was a matter of much controversy, but as Valparaiso was decided upon as the final objective point, a line giving the shortest possible connection between Buenos Aires and Valparaiso consistent with sound engineering was chosen. These cities lie practically in the same latitude, so the line runs practically due east and west. The plan was to build 113 miles beyond Mendoza, a city 2,359 feet above sea level at the foot of the eastern slope of the Andes, to the summit of the Cumbre Pass, at an elevation of 12,605 feet, where operations on the Argentine side would cease. It was expected that the government of Chile would co-operate in the construction of the transandine railway by causing operations to be commenced on the Chilean side at the town of Santa Rosa de los Andes, a point 2,625 feet above the Pacific, the terminus of the existing Chilean railway. From Santa Rosa the distance to the end of the proposed Argentine section was only 47 miles, but the route offered heavy engineering difficulties.

For seven years financial and political complications hampered the work. The first link in the transcontinental system was the section built by the Argentine government in 1880 from Villa Mercedes to Mendoza, a distance of 222 miles, and called the Argentine Great Western. In 1883 the Clark brothers built the section 428 miles long between Buenos Aires and Villa Mercedes. Subsequently the Clark brothers' interest in these two lines was acquired by the Buenos Aires and Valparaiso Transandine Railway Corporation of London, which was granted a concession and subsidy in 1886 for the construction of the section from Mendoza to the Chilean frontier. For the transandine section, metre gauge was adopted. Though the distance between Mendoza and Santa Rosa on the Chilean side was only 160 miles, work progressed so slowly that in 1903 a gap of 45 miles still remained over which the railway was yet to be constructed. This section offered the greatest engineering difficulties of the whole line.

For several years the construction work on the Chilean side was under the superintendence of the Clark brothers. Lack of the necessary capital, however, led to a judicial sale of the property in 1900 and its subsequent acquisition by the Chilean government. A law was enacted in February, 1903, empowering the President of Chile to contract by public tender for the construction of a metre-gauge railway from the city of Santa Rosa to the summit of the Cumbre Pass, there to connect with the railway under construction on the Argentine side. The government of Chile guaranteed for the term of twenty years 5 per cent interest on a sum not to exceed $7,209,750, to be paid in three instalments, on the completion and equipment with the necessary rolling stock of three sections of the line, from Santa Rosa to Juncal, from Juncal to Portillo, and from Portilla to the junction with the Argentine line. On December 15, 1903, the contract was awarded to the firm of W. R. Grace & Co., of New York and London, the amount of the guaranty granted being $6,569,775.

From this date the progress of the Transandine Railway was accelerated. On June 30, 1906, the first section of the line on the Chilean side, from Santa

Rosa to Juncal, a distance of 32 miles, was accepted and taken over from the contractors by the government. Work on the second section, from Juncal to Portillo, was approaching completion by the summer of 1908, and it was then estimated that the third Chilean section, from Portillo to the junction with the Argentine line, would be completed by June, 1910. According to the latest authentic information, the entire Transandine Railway system is expected to be completed and open to through public traffic not later than March, 1911.

IMPROVEMENTS IN STEEL RAILS.

THE EXPERIENCE OF THE NEW YORK CENTRAL LINES IN THE USE OF FERRO-TITANIUM.

The Iron Age.

IN a review in these columns last month, some reference was made to the effect of titanium on rail steel and the extent to which its use has been developed during the past two years in the United States. The New York Central Lines have gone most extensively into the development of the ferro-titanium rail, under the direction of Dr. P. H. Dudley. A considerable mileage of the New York Central tracks lies in higher latitudes, where the temperature falls at intervals in the winter to 30 to 40 degrees below zero, and in recent winters rail breakages in these districts were frequent. For the past two years the management have devoted every possible effort to ending these rail failures by the development of a rail steel which should be absolutely safe in the track and at the same time resist wear. The success they have attained is described in *The Iron Age* for March 25.

In the recent specifications there has been some reduction in the permissible percentage of carbon. Formerly 0.55 to 0.65 per cent. was specified for 100-pound rails containing a maximum of 0.06 per cent. phosphorus. The present carbon maximum is 0.55 per cent. for 100-pound rails, 0.53 per cent. for 80-pound rails, and 0.50 per cent. for 75-pound rails. Certain new regulations have been made also in rolling: not more than three 100-pound, 33-foot rails are to be rolled from an ingot, and of 80-pound rails, not more than four. Short, stubby ingots are preferred; in no case must the length exceed three times the larger dimension of the base, the ingots usually dealt with being 19 inches square.

The manufacture of ferro-titanium rails has been carried on principally at the Lackawanna Steel Company's works at South Buffalo. "It is probably more correct to speak of these rails as rails made by a process involving the addition of ferro-titanium to the molten metal, since titanium may or may not be found in the rolled product. In general it passes off in the slag, whereas in the case of nickel steel rails or manganese rails, for example, the alloy produces its effect by remaining in the steel. For the electric division of the New York Central, extending from New York City to Mt. Vernon, 5,000 tons have already been delivered. For the Boston & Albany 7,000 tons have been ordered and a portion of the order has been delivered. For curves on the Pennsylvania Division 2,400 tons have been ordered. Some of the titanium rails laid on the electric division were put into a crossover at Fifty-sixth street, Grand Central Station, New York, which is the equivalent of a 10 degree curve. In six months the titanium rails have lost from flange wear less than one-third of the amount of wear occurring in four months with the ordinary 1907 rails which preceded them. The chemical composition of both rails was as follows: Carbon, 0.45 per cent.; manganese, 0.96 per cent.; silicon, 0.13 per cent.; phosphorus, 0.095 per cent. The ingots from which the rails were rolled were sound, without blowholes or decided segregation.

"The use of titanium alloy, it is found, has added to the soundness of the ingots and the homogenity of the metal, largely eliminating blowholes. It has added to the wearing qualities of the steel, being particularly of service in the case of Bessemer metal of as high as 0.10 per cent. phosphorus, in which the carbon

must be kept down. Thus with titanium the prime requisite of safety is secured and also a much greater resistance to wear than is found in the plain rail.

"The increase in the cost of ferro-titanium rails naturally depends on the amount of the alloy added. The addition of crushed ferro-titanium is made in the ladle as the steel is poured from the converter. The percentages used have varied. Some of the rails already laid are from steel to which an addition of 75 pounds of ferro-titanium of a 10 per cent. alloy was made for 8.8 tons of steel, and in some cases a less percentage of ferro-titanium was used. By the above additions of ferro-titanium and a 9 per cent. crop satisfactory wearing quality has been secured in addition to the necessary ductility to insure against breakages. Such an addition of the alloy and the extra time called for in the Bessemer department by the requirement that heats be held after the addition of the alloy, would mean an additional cost of about $2 a ton for ferro-titanium rails.

"As has been indicated by the papers presented by Dr. Dudley before various associations, the New York Central & Hudson River Railroad has been accumulating valuable data relating to rail wear and rail failures over a period of years. It was the practice in the manufacture of rails at Bethlehem and Scranton, Pa., in 1891 to 1898 for the New York Central Lines to require as low as 0.06 per cent. phosphorus, while carbon ranged from 0.55 to 0.65 per cent. for 80 and 100 lb. rails. These were all made from Bessemer steel and the heats were held after recarburizing to permit of the completion of the chemical reactions and the escape of the deoxidation products. The heats also were poled with a green wood pole to induce a violent agitation. The ingots were teemed with 1½-inch nozzles in pits and after stripping were thrown down in horizontal position in the pit, being then picked up by cranes, laid horizontally on cars and charged into horizontal heating furnaces. Throwing ingots down and charging into horizontal furnaces is, of course, not now considered the best practice, yet it has been found that after the long service of the rails produced in the period mentioned but few split heads have developed. Of the rails made at Scranton, covering more than 500,000 tons, not more than 25 split heads have been found in New York Central sections of 80 to 100-pound rails. A few more failures from split heads have occurred on the Boston & Albany, but in many of these cases the split was due to the fact that the short 20-inch splice bars had become worn and permitted increased shocks at the ends of the rails.

"The recent or 1908 practice of the New York Central Lines has been a return to the earlier Bessemer practice which yielded such satisfactory results. The slower pouring secured by the smaller nozzle is one feature, the 1½-inch nozzle being required, as against the 2½-inch size commonly used. The holding of the metal in the converter after the recarburizing additions is also required; but where the recarburizer is added in the ladle the metal is held in the ladle for the completion of the reactions. It seems to be the purpose of the New York Central to return to such of the mill methods followed in the 90's as have been found to contribute to the production of more satisfactory rails. It is recognized that the limited supply of low phosphorus ores compels the acceptance of practically 0.10 per cent. in phosphorus and therefore that a considerable reduction in carbon must be made to insure against breakages in track. It is stated that out of 80,000 tons of rails laid in 1908, the first of these going into track in the late spring, while most of the remainder were laid before August, only four broken rails have been removed in the last winter. It is true the winter of 1908-1909 has been exceptionally mild; but even so, some of the districts traversed by the New York Central Lines have had temperatures in the past winter continuing well below zero for several days.

"The small percentages of seconds turned out at the Buffalo mill, where a considerable portion of the New York Central tonnage has been rolled in the past year, particularly the ferro-titanium rails, is worthy of note. On one recent day when working on ferro-titanium rails the seconds amounted to but 0.6 per

cent., and on another day to 0.8 per cent., whereas in the case of rails made according to the generally accepted specification, 2 to 3 per cent. of seconds represents excellent practice, and considerably higher percentages are not unusual. It can be understood that such satisfactory results have been secured only by the co-operation of the mills and the railroad company. The latter has freely given the mills the benefit of its experience and all the data it has accumulated. On the other hand it stands ready to change its specifications so as to avail itself of any advanced practice that may be developed by the mills. It has placed some orders for open hearth rails and is noting carefully the results secured with such rails in track. It is also interested in what may develop from the use of the electric furnace for the purification of rail steel."

THE PRINCIPLES OF SMOKE PREVENTION.

A REPORT OF INVESTIGATIONS IN THE GOVERNMENT TESTING PLANT AND IN INDUSTRIAL ESTABLISHMENTS.

D. T. Randall and H. W. Weeks—United States Geological Survey.

A BULLETIN on the smokeless combustion of coal in boiler plants has recently been issued by the Technologic Branch of the United States Geological Survey, which gives in detail a study of the conditions found in industrial establishments in thirteen of the largest cities in eastern and central United States. Of the 500 plants inspected, sufficient data was collected from 284 to be of value for the report. In addition to these investigations, the bulletin records the results of extended tests to determine the conditions necessary for the smokeless combustion of bituminous coal in boiler plants. It is shown not only that bituminous coals high in volatile matter can be burned without smoke, but also that large plants carrying widely fluctuating loads, where boilers over banked fires must be put into service quickly and fires forced to the capacity of their units, can be operated without producing smoke that is objectionable. Proper equipment, efficient labor, and intelligent supervision are the necessary factors. The conclusions drawn by Messrs. Randall and Weeks, who prepared the bulletin, form a very clear and comprehensive summary of the principles of smoke prevention. They are presented below as an interesting amplification of Mr. Coes' article on the same subject on another page of this number.

Smoke prevention is possible. There are many types of furnaces and stokers that are operated smokelessly. Credit is to be given to any one kind of apparatus only in so far as the manufacturers require that it shall be so set under boilers that the principles of combustion are respected. The value of this requirement to the average purchaser lies in the fact that he is thus reasonably certain of good installation. A good stoker or furnace poorly set is of less value than a poor stoker or furnace well set. Good installation of furnace equipment is necessary for smoke prevention.

Stokers or furnaces must be set so that combustion will be complete before the gases strike the heating surface of the boiler. When partly burned gases at a temperature of, say, 2,500 degrees F., strike the tubes of a boiler at, say, 350 degrees F., combustion is necessarily hindered and may be entirely arrested. The length of time required for the gases to pass from the coal to the heating surface probably averages considerably less than one second, a fact which shows that the gases and air must be intimately mixed when large volumes of gas are distilled, as at times of hand firing, or the gas must be distilled uniformly, as in a mechanical stoker. By adding mixing structures to a mechanical stoker equipment both the amount of air required for combustion and the distance from the grates to the heating surface may be reduced for the same capacity developed. The necessary air supply can also be reduced by increasing the rate of combustion. No one type of stoker is equally valuable for burning all kinds of

coal. The plant which has an equipment properly designed to burn the cheapest coal available will evaporate water at the least cost.

Although hand-fired furnaces can be operated without objectionable smoke, the fireman is so variable a factor that the ultimate solution of the problem depends on the mechanical stoker—in other words, the personal element must be eliminated. There is no hand-fired furnace from which, under average conditions, as good results can be obtained as from many different patterns of mechanical stoker; and of two equipments the one which will require the less attention from the fireman gives the better results. The most economical hand-fired plants are those that approach most nearly to the continuous feed of the mechanical stoker. The small plant is no longer dependent on hand-fired furnaces, as certain types of mechanical stokers can be installed under a guarantee of high economy, with reduction of labor for the fireman. In short, smoke prevention is both possible and economical.

During 1904 to 1906 coals from all parts of the United States were burned at the Government Fuel Testing Plant at St. Louis, in furnaces which were in the main of the same design. Most of the tests were made on a hand-fired furnace under a Heine water-tube boiler. The lower row of tubes of the boiler supported a tile roof for the furnace, giving the gas from the coal a travel of about twelve feet before coming into contact with the boiler surface. This furnace is more favorable to complete combustion than those installed in the average plant. A number of coals were burned in this furnace with little or no smoke, but many coals could not be burned without making smoke that would violate a reasonable city ordinance when the boiler was run at or above its rated capacity.

In 1907, the steaming section of the St. Louis plant was moved to Norfolk, Va., where subsequent tests of this nature were made. The plant at Norfolk was equipped with two furnaces—one fired by hand and the other by a mechanical stoker. In the course of the steaming tests some special smoke tests were made and the influence of various features in smoke production was noted. As the tests were made as far as possible under standard conditions with a minimum variation in boiler room labor the results bring out the importance of other factors such as character of fuel and furnace design.

A brief summary of the general conclusions is as follows:

A well-designed and operated furnace will burn many coals without smoke up to a certain number of pounds per hour, the rate varying with different coals, depending on their chemical composition. If more than this amount is burned, the efficiency will decrease and smoke will be made, owing to the lack of furnace capacity to supply air and mix gases.

High volatile matter in the coal gives low efficiency and vice versa. The highest efficiency was obtained when the furnace was run at low capacity. Forcing the furnace decreased the efficiency.

With a hand-fired furnace the best results were obtained when firing was done most frequently, with the smallest charge.

Small sizes of coal burned with less smoke than large sizes, but developed lower capacities.

Peat, lignite, and sub-bituminous coal burned readily in the type of tile-roofed furnace used and developed the rated capacity with practically no smoke.

Coals which smoked badly gave efficiencies 3 to 5 per cent lower than the coals burning with little smoke.

Briquets were found to be an excellent form for using slack coal in a hand-fired plant. They can be burned at a fairly rapid rate of combustion with good efficiency and with practically no smoke. High-volatile coals are perhaps as valuable when briquetted as low-volatile coals.

A comparison of tests on the same coal washed and unwashed showed that under the same conditions the washed coal burned much more rapidly than the raw coal, thus developing high rated capacities. In the average hand-fired furnace washed coal burns with lower efficiency and makes more smoke than raw coal. Washed coal offers a means of running at high capacity, with good efficiency, in a well-designed furnace.

Forced draft did not burn coal any more efficiently than natural draft. It supplied enough air for high rates for combustion, but as the capacity of the boiler increased the efficiency decreased and the percentage of black smoke increased.

Most coals that do not clinker excessively can be burned with 1 to 5 per cent greater efficiency and with a smaller percentage of black smoke on a rocking grate than on a flat grate.

Air admitted freely at firing and for a short period thereafter increases efficiency and reduces smoke.

As the CO in the fuel increases the black smoke increases; the percentage of CO in the flue gas is therefore, in general, a good guide to efficient operation. However, owing to the difficulty of determining this factor, combustion cannot be regulated by it.

The simplest guide to good operation is pounds of coal burned per square foot of grate surface per hour.

The total number of steam plants having boilers fired by hand is far greater than the total of plants with mechanical stokers, but if the comparison is based on total horse power developed the figures show less difference. Particularly is this true in sections of the Central West, where mechanical stokers are generally used at large plants. As a general rule, hand-fired plants do not have proper furnaces, and methods of operation are far from conducive to good combustion. Coal is usually fired in large quantities, and little opportunity is given for the air and gases to mix before the heating surface is reached and combustion is arrested. In all the hand-fired plants visited success in smoke prevention has been obtained chiefly by careful firing. The coal was thrown on often in small quantities; the fire was kept clean, enough ash to prevent the passage of air through the fire never being allowed to collect on the grate; and more air was supplied at firing than after the volatile matter had been distilled. Even with such precautions the plants might have made objectionable smoke at times but for the fact that usually means were employed for mixing the gases and air before they reached the heating surface.

Some general conclusions from the facts set forth in the bulletin are as follows:

The flame and the distilled gases should not be allowed to come into contact with the boiler surfaces until combustion is complete.

Fire-brick furnaces of sufficient length and a continuous or nearly continuous supply of coal and air to the fire make it possible to burn most coals efficiently and without smoke.

Coal containing a large percentage of tar and heavy hydro-carbons are difficult to burn without smoke and require special furnaces and more than ordinary care in firing.

Briquets are suitable for use under power-plant conditions when burned in a reasonably good furnace at the temperature at which such furnaces are usually operated. In such furnaces briquets generally give better results than the same coal burned raw.

In ordinary boiler furnaces only coals high in fixed carbon can be burned without smoke, except by expert firemen using more than ordinary care in firing.

Combinations of boiler-room equipment suitable for nearly all power-plant conditions can be selected, and can be operated without objectionable smoke when reasonable care is exercised.

Of the existing plants some can be remodeled to advantage. Others can not, but must continue to burn coals with inefficient results, accompanied by more or less annoyances from smoke. In these cases a new, well-designed plant is the only solution of the difficulty.

Large plants are for obvious reasons usually operated more economically than small ones, and the increasing growth of central plants offers a solution of the problems of procuring heat and power at a reasonable price and without annoyance from smoke.

The increasing use of coke from by-product coke plants in sections where soft coal was previously used, the use of gas for domestic purposes, and the purchase of heat from a central plant in business and residence sections all have their influence in the solution of the smoke-prevention problem, in making possible a clean and comfortable city.

A NEW AUTOGENOUS WELDING PROCESS.

THE PROPERTIES OF LIQUID GAS, A SUBSTITUTE FOR HYDROGEN AND ACETYLENE.

E. F. Lake—American Machinist.

A NEW "autogenous" process for the welding and cutting of metals has recently been invented by M. M. Wolf, of Basseldorf, Switzerland, which substitutes for the hydrogen and acetylene commonly used for these purposes a liquid gas obtained from the distillation of heavy oils, paraffin oils, crude petroleum and other materials of a similar character. The processes of distillation and cleaning are the same as those used in the manufacture of any of the oil gases. To these M. Wolf has added a special process which, by the use of cold and pressure, separates the difficultly liquifiable gases, hydrogen, methane, etc., from the more easily liquified ethane, propane, pentane, etc. After the gas has passed through this process it is charged into steel bottles at a pressure of from 1,200 to 1,500 pounds per square inch. This transforms it into a liquid, but when the high pressure is removed it immediately gasifies, and at the ordinary pressure of the atmosphere it is a dry inflammable gas. The following account of its properties is taken from an article by E. F. Lake in *The American Machinist* for April 22.

Liquid gas contains none of the poisonous hydro-carbons. It consists principally of ethylene and ethane, with small quantities of methane, benzol, air and carbon dioxide. It is explosive only in mixtures containing from 4 to 8 per cent of gas, a range of 4 per cent; hence it is much less likely to explode than city gas or acetylene. The danger of explosion is still farther reduced by the fact that it is 1.027 times as heavy as air and mixes with the latter with difficulty. A hotter flame can be produced by combining liquid gas with oxygen in a torch than by any of the other known gases. The temperature of the oxy-liquid gas flame is 7,000 degrees F., while the oxy-acetylene flame gives 6,300 degrees and the oxy-hydrogen flame but 4,800 degrees. The liquid gas contains 2,500 thermal units more per cubic metre than acetylene. It burns with a short, pointed flame with a cone shaped centre, like the oxy-acetylene flame. Liquid gas is bought from the manufacturer in bottles at a cost which about equals that of coal gas at $1 per thousand cubic feet.

When the gas is to be used for welding, it is allowed to flow from the steel bottle into an expansion tank until any desired pressure up to 60 pounds per square inch is reached. At this point the pressure is released by a safety valve. The tank is provided with an automatic pressure regulator and a pressure indicator. The torch is much simpler than that used for oxy-acetylene welding, since the very low explosive properties of the gas render unnecessary any mechanism to prevent backfiring. It consists of an air chamber in the end for the purpose of keeping the handle cool. The gas and oxygen are passed through this air chamber into a mixing chamber which occupies the front half of the body of the torch. At the rear of this chamber the gas is carried out through a pipe coiled around the stem of the torch and in this way is preheated. Oxygen passes out of the forward end of this chamber through another pipe that meets the gas pipe at the nozzle of the torch. Through the central stem is carried the mixed gas, and the three are all combined at the nozzle into a good mixture for combustion. With this torch only three tips are needed for welding or cutting any kind or thickness of metal. In the torch used for metal cutting, it is not necessary to coil the pipe around the stem to warm the gas. The gas and oxygen are piped into the mixing chamber and carried out to the stem to the work. As in other cutting torches, an extra jet of oxygen is carried by a lower tube to strike the work just ahead of the flame, to localize the heat and remove the burnt products.

At the works in Switzerland steel and iron up to 14 inches in thickness have been cut by this process with practically no loss of metal. The cut is no wider than would be made with a saw and the

metal is not perceptibly heated on either side of the cut. Steel 2 inches wide and ¾ inch thick can be perfectly cut in less than a minute. Welding can be done on cast iron, brass, bronze, aluminium and other metals. Liquid gas without oxygen is useful for soldering and brazing. Brazing torches are made with interchangeable tips which will produce any size of flame desired. The portability of liquid gas makes it especially useful as a fuel for heating paint scrapers, plumber's tools and other things of a similar nature.

Liquid gas is useful for lighting shops located away from a gas supply, for outside illumination or for lighting vehicles. Various lamps have been specially designed for its use, though ordinary gas fixtures may be used. A 50-Hefner candle power lamp uses ¾ cent worth of gas per hour, a 250-Hefner candle power, 2½ cents worth, and a 100-Hefner candle power lamp giving a very white light costs about 1 cent per hour. Liquid gas is not affected in any way by the outside atmosphere and it can be stored and used in any convenient place. Neither the gas nor the products of combustion attack metal; hence the burners, torches and fittings last a long time. This property is of especial benefit in the welding of metals. The gas does not injure the metal in the joint and strong and durable welds are the result.

REFUSE DESTRUCTORS.

A REVIEW OF THE DESIGN AND WORKING OF MODERN DESRTUCTOR PLANTS.

William F. Loveday—Association of Municipal and County Engineers.

ONE of the most important achievements of municipal engineering within recent years is the solution, by means of refuse destructors, of the problem of economically disposing of city wastes. Destructor practice has now been developed to such a point that, given an analysis of the refuse and the quantity of incombustible, vegetable and other matter, the results to be obtained from any specified quantity can be calculated with almost mathematical exactness. A paper read by Mr. William F. Loveday before the Incorporated Association of Municipal and County Engineers gives a brief but comprehensive account of the design and working of a modern destructor plant. We take the following abstract from a reprint of the paper in *The Surveyor* for April 9.

Progress and development in destructor practice during recent years have been along the lines of amelioration of the conditions for the workman in the destructor house, and introduction of details in construction which ensure fairly high temperatures and a normal ruling condition in the furnace proper. More efficient means of ventilation have been devised, which have removed to a large extent the disagreeable conditions of dust and unpleasant odors found in old plants. In the best of recent plants means are provided for renewing the air four or five times an hour, the vitiated air being withdrawn through ducts and led to the fan inlet, whence it is propelled to the furnace ashpits. In details of construction, one of the most important improvements has been the introduction of devices for facilitating the most laborious operation in destructor working, the clinkering of the fires. Taper castings are used to form lines of cleavage between and in the grates, which greatly facilitate the breaking up of the fires before withdrawal.

There are practically only two types of destructors, the single cell and the continuous grate. These main classes may be subdivided according to the method adopted in feeding the refuse into the furnace, into top-feed destructors, in which the refuse is fed in through the top directly on the fire, or on a drying or desiccating hearth from which it is pulled forward to the fire bars; back-feed destructors, in which the refuse is fed in through an opening in the back and clinkered from the front; and front-feed destructors, in which the refuse is fed and clinkered through the same opening. The handling problem is simplified in top-feed furnaces but they have great objections from the combustion and evaporization point of view. A

load of very wet material, or one containing an unusual quantity of incombustible matter, which must of necessity go into a particular cell, has the effect of reducing very considerably the temperature in that cell. Again, the refuse has to be pulled forward on the bars, and the difficulty of handling long and heavy firing tools over a hot fire renders it next to impossible to get an even thickness and uniform density over the grate. The forced draft will take the line of least resistance and will escape through the thin parts, to the detriment of combustion in the thicker portions, which most require its aid. The front or back feed enables the stoker to apply the refuse more evenly and with more discretion. The operation of charging is much slower, but in destructor practice, as in boiler firing, the introduction of small quantities at a time is a necessary condition for obtaining the best results.

In the single-cell type of destructor the cell is an isolated furnace, having an opening for charging the refuse on the grate bars, and another opening at either the back or front as an outlet for the products of combustion. The latter pass into a main flue which serves a number of cells built in parallel. In the isolated cells the process of combustion must go on unaided by the heat of any adjoining fire, and the temperature obtained depends entirely on the quality of the refuse charged. In one type of furnace a boiler is placed between each pair of cells, under which the gases are passed immediately after leaving the latter. It has the disadvantages that the gases are cooled before complete combustion has taken place, and the boiler is adversely affected by the admission of cold air to the cell at the time of clinkering.

Furnaces of the continuous-grate type consist of a number of grates in line, each having a separate ash pit, but with the space above the fire bars communicating. Before reaching the boiler the gases pass the whole length of the series of grates and through a combustion chamber. Combustion of the charge on each grate receives a large amount of assistance from the other fires and, consequently, the time of initial ignition and combustion is considerably less than in the single-cell type of furnace. The continuous grate type is free from the wide fluctuations of temperature which in the single-cell furnace affect the firebrick linings very seriously; the presence of other fires in the former prevent any serious cooling of the furnace walls during the operation of clinkering the charge on any one grate.

To fulfil the primary objects for which it exists, the destruction by fire of obnoxious matter without nuisance and the utilization of the heat generated in the process, the design of a destructor furnace must possess the following essential features: a continuous furnace chamber with the grate laid off in sections, each section independently controlled and so operated that it is a complement of the others; provision for heating and regulating the air supply for the necessary forced draft; a combustion or dust settling chamber and a steam generator. As has been pointed out above, combustion in the continuous-grate type of furnace is more perfect than in the isolated-cell type; as a result a higher and more regular temperature is attained and a more rapid rate of burning. The rate of burning is materially increased by an undulating arch over the grates, which deflects the gases from one fire on the next. The rates of burning in a three grate unit are about in the relation 3, 4 and 5. Mr. Loveday's tests have given on the three grates a consumption of, respectively, 55.21, 74.6, and 89.6 pounds per square foot of grate per hour.

The cycle of operations in refuse destruction consists of three distinct stages, in each of which the features embodied in the furnace design play an important part, the charging stage, the burning stage and the clinkering stage. To facilitate charging, a storage bunker, usually large enough to hold half a day's supply of refuse, is placed just opposite the charging door of the furnace in a position convenient of access for the fireman, who charges and spreads the refuse in the furnace in one operation. The combustion process is assisted by a forced-draft air supply which is heated by an air heater or regenerator. Control and regulation of the air supply are obtained by means of a special valve which

can be manipulated and adjusted to meet all conditions.

An essential to efficient working of a destructor furnace is the maintenance of a uniform ruling temperature in the furnace clinker. Until recently no means were available to prevent the cooling of the furnace fires by the inrush of cold air during the clinkering process. An ingenious device by which it is possible automatically and continuously to control the conditions determining the efficiency of combustion in the destructor furnace, which has recently been installed in a plant in New York, is an entirely new feature in destructor practice which marks a very great advance.

The steam jet is not a satisfactory means of supplying forced draft; it adds air saturated with steam to a fuel already heavily charged with moisture. It is much better to employ a fan to supply to the furnace air heated by the waste gases from the boiler. The advantage of preheating the air may be expressed in terms of coal; the introduction of air at 300 degrees F. is approximately equivalent in effect to the addition of about one hundredweight of coal to each ton of refuse. In addition to supplying forced draft the fan serves a useful purpose in ventilation. The ventilation of a destructor house should be from the outside to the inside, to prevent the spread of objectionable odors about the neighborhood. The best means of securing proper ventilation is by an air duct in the roof, communicating with the shaft supplying the air for forced draft for the furnaces. The air is drawn from every part of the house simultaneously, heated and passed through the furnaces, and as the only means of ingress for the fresh air should be at the openings at the ground level, this method ensures that the inside of the building is as fresh as it is possible to be.

To sum up, the features which should be insisted upon in any destructor installation are: cleanly operation, absolute freedom from nuisance to the neighborhood, and maximum comfort for workmen; minimum capital cost, consideration being given to the value of steam and clinker, and general efficiency; low maintenance charges combined with low maintenance cost; efficient and economical means of preheating the air supply; maximum evaporation; regular steaming; and clinker of a marketable quality.

In the concluding part of his paper, Mr. Loveday describes the destructor installation at Stoke Newington, England, and gives some results of tests on various other plants. Especially interesting is the report of an eight-hour trial run of a three-cell unit at St. Albans. The total weight of refuse burned was 26,166 pounds. The grate area per cell was 14.3 square feet. The products of combustion were passed under a water tube boiler with 1,966 square feet of heating surface, fed with water at an average temperature of 63 degrees F. The average boiler pressure was 159 pounds gauge and the average temperature of the steam leaving the superheater 575 degrees. The actual evaporation per pound of refuse was 2.1 pounds of steam, equivalent to 2.75 pounds from and at 212 degrees F. 24.4 per cent of the weight of refuse charged remained as clinker. Two men charged and clinkered the furnace during the test at 5½d. each per hour, making the cost of charging and clinkering 7¾d. per ton.

THE OPEN-TANK PROCESS OF TIMBER PRESERVATION.

THE RELATION OF NON-PRESSURE TO PRESSURE PROCESSES IN WOOD PRESERVATION.

W. F. Sherfesee—Engineering News.

WHEN the preservative treatment of timber was first introduced into the United States, about 30 years ago, practice in Europe had passed through the periods of experiment, of discussion and of innovation, and the industry had assumed what promised to be its final shape. The use of mercuric chloride, copper sulphate and other antiseptic salts had been tried and abandoned, and creosote, injected into seasoned timber under pressure, had largely supplanted its cheaper rivals as the standard preservative material. The pio-

neers in the industry in America were glad to avail themselves of European experience, and the creosote pressure process became standard practice in the United States. It remained for many years the only process in common use, and it still holds its position as the standard for commercial practice in both Europe and America, but its monopoly of the whole field is a thing of the past. Within recent years conditions have created a need for a cheap process which the pressure process could not fulfil, and a wide development of the "open-tank" or non-pressure process has been the result. The relation of the latter to the older practice is discussed in an article by W. F. Sherfesee in *Engineering News* for March 4, of which the following is a brief abstract.

American practice in wood preservation differs from European practice in one very important particular. Abroad the timber is generally allowed to become air dry before treatment. In the United States preliminary processes for artificially seasoning the timber were adopted and have been persisted in, though they have given but indifferent satisfaction. Common practice in creosoting in America, and the same process is used in the injection of zinc chloride, consists of three principal operations or processes, a bath of live steam, a vacuum and the application of the preservative under pressure. The timber, carried on iron trucks, is treated in large horizontal cylinders. The average pressure of the live-steam bath is about 20 pounds per square inch, and its average duration about 4 hours. The vacuum is drawn for about the same length of time as the steam bath. The cylinder is then filled with the preservative, at a pressure of about 100 pounds per square inch, until the required amount has been injected, after which the surplus is blown back to the receiving tanks by compressed air. The whole process takes about ten hours and with some classes of timber may take much longer. The plants are expensive to instal and the process requires skilled supervision.

It is now known that neither the steam bath nor the vacuum accomplish the desired result in the seasoning of timber. The steam bath has a certain value in warming the timber but unless it is applied with skill it is almost certain to cause a permanent reduction in strength. The vacuum treatment as a means of extracting moisture from the wood was based on erroneous theoretical opinions, and, instead of lessening the amount of moisture in the wood, the steam bath and the vacuum often increase it. The development of the open-tank process, however, has been due primarily neither to the time required by the pressure process nor to the negative or possibly injurious effects of some of its operations. The factor which has been chiefly responsible is the heavy expense involved in the purchase and installation of the pressure plant, an expense which confines such plants to large commercial companies which demand a very large and fairly constant supply of structural timber comparatively resistant to the entrance of the preservative.

There is no real ground for rivalry between the two systems. Although the boundaries of their fields of usefulness may occasionally overlap, each process has a field of its own, a condition to meet for which the other is inadequate. The non-pressure processes are nothing more than a natural development of the old pressure system, made necessary by the need for a simpler and less expensive method for the small user or for cheaper classes of timber. With a decreasing supply of structural timber and an increasing price, the need became pressing for a process by which timber of different kinds and for different purposes could be treated cheaply and efficiently, in a plant inexpensive to install and simple to operate. It was evident that effort could be exerted along but three main lines, the simplification of the process for injecting the preservative into the timber, reduction of the cost of the plant by the simplification of the mechanical apparatus, and reduction of the amounts of the preservatives without decreasing the efficiency of the treatment. It was evident also that none of these lines could be followed independently

The first step towards simplification was a thorough study of the effects of the three operations in the pressure pro-

cess. The work was greatly simplified as soon as American engineers admitted what was already generally recognized abroad, that the steam bath and the vacuum are inferior to air seasoning, and often accomplish results directly opposite to those desired. At one stroke it was possible to eliminate entirely two of the most expensive and difficult processes, with the substitution of nothing more complicated than the stacking of the timber in the open air. The crux of the problem, however, still waited solution; the application of artificial pressure was still essential to a satisfactory impregnation, for simple soaking of the timber is inadequate. After much experimentation success was at last found in two methods, first, the usé of atmospheric pressure to take the place of artificial pressure, and, second, the employment of the pressure generated by heat thrcugh the vaporization of the preservative in closed retorts.

In the open-tank process atmospheric pressure alone is used. During the period of air seasoning much of the moisture in the wood is evaporated and its place taken by air. When the wood is ready for treatment it is immersed in a hot liquid which serves principally as a heating medium and may or may not be a preservative. The heating of the wood fibre causes a rapid expansion of the air in the cells and intercellular spaces, and a part of the air, carrying some of the remaining moisture, is driven out of the timber and escapes through the liquid into the open air. This bath is continued until its effects have penetrated to a sufficient depth. The temperature of the surrounding fluid is then quickly lowered, either by removing the timber from the hot liquid and plunging it quickly into a bath of the cold preservative, by shutting off the heat and allowing the timber to remain in the preservative as it cools, or, best of all, by running off the hot liquid into tanks and admitting almost simultaneously a preservative at a lower temperature. As the temperature falls, the air in the wood structure contracts, and the partial vacuum formed, increased by the condensation of moisture, is satisfied by the entrance of the surrounding preservative.

Reduced to its lowest terms, the apparatus absolutely necessary for the application of the open-tank process consists of an open vat large enough to hold the timber, so arranged that a fire can be built underneath. Considerations of economy in operation, however, recommend the installation of more elaborate plant, except in very exceptional cases. The use of steam coils for heating gives closer temperature regulation and lessens the cost of fuel. Much time can be saved by having a second tank near at hand, containing cold preservative, into which the timber can be plunged as soon as the hot bath is completed. In handling heavy timber it is much easier and cheaper to let it remain in the first tank and to change the bath by means of piping in connection with underground wells and overhead storage tanks. In very large plants it is economical to use a large, horizontal, cylindrical treating tank into which the timber is introduced on trucks. To such installations the term "open-tank" will not apply. The process is essentially the same as that of the simplest fire-heated vats, but the preservative is no longer exposed to the open air; in fact every effort is made to prevent the vapors from passing off into the atmosphere. In plants of this sort is usually found every practical mechanical device which will assist in reducing the cost of operation or in improving the efficiency of the treatment. The loss of preservative by evaporation, which in the open tanks is sometimes as high as 35 per cent, is prevented by collecting and condensing the vapors. Despite a similarity in appearance between cylindrical non-pressure retorts and those used in standard pressure treatment, the cost of installing a commercial non-pressure plant is only about one-third that of a pressure plant of similar capacity. The regulation of the absorption in a well conducted non-pressure plant is quite as accurate as in common practice at pressure plants, and with the use of closed retorts loss by evaporation is practically eliminated.

The demand for an "empty-cell" treatment which would leave merely a coating of preservative around the cell walls instead of leaving the lumina and

intercellular spaces filled, thus securing the deepest penetration with the least absorption, has been successfully met by the non-pressure process. In pressure plants this is achieved by the use of force, air and vacuum pumps. In the non-pressure process an equally efficient result is obtained by withdrawing the timber from the preservative before the latter has penetrated to the depth affected by the hot bath. The outer layers only are given time to become saturated, and when the timber is removed from the bath, the surplus preservative in the outer layers is drawn down to the depth to which the heat penetrated by the still unsatisfied vacuum in the inner layers.

"It is not difficult to forecast the final place, in the industry of wood preservation, which the non-pressure processes are to hold. All misconception will be cleared away if it is remembered that their development is not intended to provide a substitute for, or to compete with, the pressure processes. Generally speaking, the non-pressure plants will not draw work from the larger commercial plants but, on the contrary, they will be used principally for the treatment of timber which otherwise would remain untreated. They provide a cheap and efficient method for treating certain of the more porous classes of timber in isolated locations, and they are for the small users to whom the use of the commercial pressure plants is prohibited."

SHIP PROPULSION BY CONTRARY TURNING SCREWS.

A REPORT OF INVESTIGATIONS ON THE EFFICIENCY OF SCREWS TURNING IN CONTRARY DIRECTIONS ON A COMMON AXIS.

Lieut.-Colonel G. Rota—Institution of Naval Architects.

THE propulsion of ships by two contrary turning propellers on a common axis has been the subject of investigation at various times since the method was first applied to marine purposes by Ericsson in 1839. More recently a general application of the same principle has been made in the propelling gear of the Whitehead and similar torpedoes, and as lately as 1892 a little passenger steamer with contrary turning screws was in service on Brent Lake. Within the last two years also a patent has been claimed for a double propeller on a common axis in association with an oil engine and belt drive. The latest investigations on a considerable scale have been made by Lieut.-Colonel G. Rota, who communicated his results to the Institution of Naval Architects on April 1. The main portion of his paper is given in full abstract below, from *Engineering* for April 9.

"The guide-blade of Thornycroft's system, and also the systems of Rigg and Parsons, can be considered as special cases of the double-propeller arrangement, the after screw being replaced by guide-blades. At the time that the above arrangements were devised, the reciprocating engine was the only kind of engine available for marine propulsion, and it was only possible to drive one of the two shafts (the inner one) off the engine, as no arrangement of gearing or belt-driving was found to be practically workable for the outer propeller. The working-screw was therefore placed in front of a fixed blade device, which acted as a guide to divert the stream of water from the screw in parallel lines astern.

"But the fixed guide-blades, independently of their beneficial influence on the efficiency, certainly increase the resistance of the hull. It is well known, however, that this increase of resistance can be reduced if the guide-blades are not fixed, but form instead an integral part of the propelling apparatus. With such an arrangement the stream of water is conveyed to the after part of the propeller in a more convenient direction, thus ensuring the beneficial influence of that propeller on the forward one.

"In his interesting paper of 1888 Professor Greenhill, in explainig his theory of the screw propeller, first analysed the case of the double-screw propeller on a common axis, and pointed out the maximum efficiency it would be possible to obtain by a special arrangement for increasing the pitch of the screws. I ven-

ture to say that a gain of efficiency is generally obtained by the double-screw propellers on a common axis, not as a consequence of increasing the pitch under the Greenhill arrangement, but merely by the subdivision of the propeller into two parts acting in opposite directions, yet of constant pitch.

"As the result of careful observations it may reasonably be assumed that an increase of efficiency is possible with the above arrangement of propellers instead of the ordinary single-screw. It is well known that with an hydraulic turbine an essential condition to get good efficiency is to have the water conveyed by the guides evidently act in the same way as the forward screw on the after one. Similarly, with steam-turbines it is necessary, in every case, to have the acting fluid diverted from its ordinary course, and conveyed to the principal part of the moving apparatus in a direction more conducive to efficiency.

"Turning to the question of the reciprocal influence of hull and propeller, a most convenient result is obtained with the double-contrary turning-screws on a common axis instead of the single screw.

1. Because the increase of resistance caused by the action of the double propellers is lessened when compared with that obtained by the single screw, in consequence of the smaller screw diameter.

2. Because the gain in wake is considerable in the case of the double screws.

"Comparing the above arrangement of screws with twin-screws, we also get:—

3. Reduced length of bracket for propeller-shafts, and consequently great reduction in the resistance caused by brackets, which commonly produce a great additional resistance in the hull;

4. Increase in the depth of water above the propellers, that causes another gain of efficiency.

"Other beneficial effects will ensue when considering the question from the point of view of maritime and inland navigation. Until now, although the arrangement of double contrary turning screws on a common axis is not new, its superiority as compared with the single screw has not yet been demonstrated in a practical manner. That has been the subject of my researches, and I am indebted to His Excellency the Minister of Marine in Rome for having permitted me to carry out a complete series of trials with a steamboat in the Royal Dockyard at Castellamare di Stabia, first with a single screw and afterwards with two contrary turning screws of different diameters on a common axis with a constant pitch and also with increasing pitch, according to Professor Greenhill's rules. The results obtained by these trials showed that a great gain of efficiency is to be expected with the double screws. It appears that about 20 per cent. of the horse-power can be saved.

"In the experimental arrangement on the vessel which I had at my disposal for the trials the two shafts are driven by gearing off the reciprocating engine, and the loss of power by friction should be taken into account in estimating the probable gain resulting from the use of the double screws. Considering the improvements that should be possible in designing a complete installation on the double-screw system, there is no doubt that a considerable gain in efficiency may be secured.

"The main difficulty in the use of two propellers one behind the other, and acting in contrary directions, may be now surmounted by the use of turbine engines, by which it would be possible to drive in opposite directions two shafts with a common axis without gearing, belt, or other driving apparatus which is unsuitable for use on board ship. It might also be tried if the combination of steam-turbines and reciprocating engines could be conveniently arranged to drive respectively the outer and the inner shafts, connected with the forward and the after screws respectively. The special turbine for reversing would thus be dispensed with, and the other advantages claimed for the 'combination system' of machinery would be secured.

"The special arrangement of propellers I have described is also of advantage in disposing of the conflict between steam turbines and screw efficiency. It is well known that steam-turbines used on board ship cannot be so efficient as those used for land plants, it being impossible on board ship to have the high rate of revolution required for the highest possible

TABLE GIVING COMPARATIVE RESULTS WITH SINGLE AND DOUBLE SCREWS.

Speed of the Boat.	Single Screw in Use, I.H.P.$_1$	Double Screw in Use. First Series. I.H.P.'	Extra Loss of Power for Friction (Deduction).	I.H.P.$_2$' (corrected).	Gain of Power $\frac{\text{I.H.P.}_1\text{-I.H.P.}_2'}{\text{I.H.P.}_1} \times 100$	Second Series. I.H.P."	Extra Loss of Power for Friction Deduction.	I.H.P.$_2$" (corrected).	Gain of Power $\frac{\text{I.H.P.}_1\text{-I.H.P.}_2''}{\text{I.H.P.}_1} \times 100$
knots.					per cent.				per cent.
5	6.3	5.45	1.09	4.36	30.5	6	1.20	4.80	23.8
5½	8.3	7.32	1.46	5.86	29.4	7.90	1.58	6.32	23.8
6	11.1	10	2	8	28	10.80	2.16	8.64	22.1
6½	15.15	13.7	2.74	10.96	27.6	15	3	12	20.8
7	21	19.2	3.84	15.36	26.8	21.70	4.34	17.36	17.3

efficiency. The screws have to be reduced in diameter, and consequently their efficiency is lowered compared to that of the single screw driven by reciprocatng engines. The special arrangement of propellers, the one behind the other, which I have described, allows of a greater number of revolutions, and consequently produces a higher efficiency of the steam-turbines, and yet, with the reduced diameter of the screw, it allows a considerable increase over the propeller efficiency than is possible with a single screw. If, as I believe, the gain in power were not less than 20 per cent. in a cruising ship of moderate size—say 10,000 tons—about 250 tons would be saved in weight of machinery required to obtain 22½ knots, or, on the other hand, a knot more speed could be obtained with the same horse-power.

"The arrangement for a large installation of two shafts on a common axis and turning at high speed would, no doubt, involve difficult practical problems. There are many problems which should be subjects of careful inquiry. The experimental arrangement of shafts and propellers which I installed on the steamboat for trials has, however, been working satisfactorily for a period of about a year in the ordinary service of the boat."

The boat used in the tests was 46 feet long and 11 feet 9 inches beam, with a displacement of 25 tons, propelled by a reciprocating engine of 7.87 inches cylinder diameter and 7.08 inches stroke. The results of the trials are given in the accompanying table. In the single-screw tests a four-bladed propeller, 3 feet 9¼ inches in diameter and 4 feet 5 inches constant pitch, was used. The propellers used in the double-screw trials, first series, were similar in shape to those used in the single screw trials; the diameter was 2 feet 8 inches and the constant pitch 3 feet 1½ inches. The combined blade area of the two screws was equal to the blade area of the single screw, and the number of revolutions was √2 times the corresponding number for the single screw. In the double-screw trials, second series, the general shape of the propellers was the same as before, and the pitch according to Professor Greenhill's rules. The details were as follows:—

	After Screw.		Forward Screw.	
Diameter	1 foot 8¼ inches		2 feet 7	inches
Mean Pitch	2 " 3	"	3 " 5¾	"
Initial Pitch	1 " 7	"	2 " 11¼	"
Final Pitch	3 " 10	"	4 " 3	"

THE UTILIZATION OF SMELTER FUMES.

TECHNICAL AND ECONOMIC PROBLEMS IN THE UTILIZATION OF BY-PRODUCTS IN COPPER SMELTING.

Joseph H. Hart—The Mining World.

A BRIEF description of a successful process for the utilization of smelter fumes for the manufacture of sulphuric acid, in use at the works of the Tennessee Copper Company, was given in these columns in THE ENGINEERING MAGAZINE for February. Dr. Joseph H. Hart, however, shows in *The Mining World* for April 3, that economic conditions play so important a part in the problem that a solution successful in one place may not be commer-

cially available in another, though thoroughly practical. He says:

"Of course the easiest solution of this problem is the production of sulphuric acid from the sulphur dioxide present in the waste products of combustion. Water only is necessary to furnish the other ingredients of the sulphuric acid. Sulphuric acid, however, while it possesses a fairly large market in various parts of the world, and has a certain definite fixed value ranging from 2 to 5 cents per pound, depending upon its grade, must generally have a market close at hand, or the freight charges may prove so excessive as to render the marketing of the product a practical impossibility. This is essentially the case at the Salt Lake smelter, where, according to Mr. Franklin R. Carpenter, fully 500 tons of sulphur, as sulphur dioxide, go into the atmosphere every 24 hours, equivalent in production to 15,000 tons of sulphuric acid, and on which the freight charges for conveyance to a suitable market amount to considerably more than the total value of the product itself. Mr. Carpenter has attempted to solve the problem of collecting the sulphur dioxide and obtaining from it sulphur, which would find a ready market, both by means of mechanical refrigeration and by chemical reactions, but the problem cannot yet be said to have been solved. . . . . The suggestion of Mr. Carpenter that refrigeration can be used for the condensation of sulphur dioxide from the exhaust gases of smelting furnaces, and that the absorption system could be used for this purpose, while theoretically possible, is unavailable for practical development, on account of limitations existing in the manufacture and operation of the refrigerating unit itself. The sulphur dioxide exists in such small quantities in the waste products of combustion, generally in quantities ranging from 5 to 10 per cent of the total, and the waste products are so hot, that the utilization of the direct-compression refrigerating system, for the cooling and condensation of the sulphur dioxide would require so much refrigeration that the efficiency of the process would be small." With preliminary condensation and cooling of the gases by means of cold pipes, however, mechanical refrigeration might be employed efficiently for the last stages of condensation of the sulphur dioxide.

"The conversion of sulphur dioxide into either a solid or liquid form of comparative purity would not by any means solve the problem. Sulphur dioxide is available for refrigerating purposes itself, and has a somewhat restricted market for this purpose. It must, however, be kept in closed tanks, under pressure, for its preservation, and could be shipped to points where sulphuric acid has a ready market, and be readily manufactured into this product. The freight charges under these circumstances would be cut in half by the elimination of the water, but, undoubtedly, even under these circumstances, the charges would prove excessive.

"The separation of the oxygen from the sulphur in this material is a rather difficult chemical problem, since the heat of combustion of sulphur dioxide is quite large, and the resulting product is fairly stable. It has been suggested that a portion of the sulphur dioxide be converted into hydrogen sulphide and the two gases allowed to interact, which would result in the production of a portion at least of the sulphur in the form of pure sulphur. While this is possible theoretically, in practical operation on such a large scale, it would undoubtedly meet with serious difficulties. The same situation exists in regard to the direct transformation of the entire product into hydrogen sulphide with the subsequent elimination of the hydrogen in a suitable mechanism. Sulphur itself is undoubtedly a valuable by-product. According to Mr. Carpenter, the 500 tons available from the by-products in the Salt Lake smelter have a value of approximately $10,000 per day. But it must be borne in mind, that all of the suggestions presented up to this date, are more or less theoretical in character, and would involve a considerable outlay for their operation, with results which, at the best, could be merely considered problematic.

"The situation is, primarily, a commercial one. The production of sulphuric acid is a comparatively easy and efficient utilization of the sulphur dioxide present in the by-products of the combustion of

the average smelter. The sulphuric acid plant at Ducktown, Tenn., will undoubtedly turn in a big profit, and the market for the acid is steadily increasing.

"The real problem at hand in this particular case is, therefore, the utilization of the sulphuric acid as a home product, with a consequent production of a market, or, what is equivalent to it, the transformation of the sulphuric acid into another product, whose value is such that it can be readily transported to a market at a profit, and freight charges reduced as well.

"Sulphuric acid is used in an innumerable number of industries throughout the civilized world. It is used in paper mills to a considerable extent; in oil refineries; for the disintegration of phosphate rock; to a small extent in sugar refineries for the purification of the sugar, and in a large number of other industries as well to a more or less restricted extent. Its chief utilization is in the production of other acids of commerce. Hydrochloric acid, one of the chief of these, is readily produced almost spontaneously in the chemical reactions that take place between sulphuric acid and a number of the common chlorides. Thus ordinary common salt, or sodium chloride, NaCl, is at once available at minimum cost in this particular development, from the salt beds operated in the vicinity of the Great Salt lake. The reaction between sulphuric acid and sodium chloride is a double one. The first of these occurs spontaneously, and the latter with gentle application of heat. In the first the sulphuric acid reacts with the salt and produces sodium acid sulphate and hydrochloric acid, as follows: $H_2SO_4 + NaCl = NaHSO_4$ and HCl.

"The heating of this material with an excess of salt results in a further action and the substitution of sodium in place of the hydrogen in this product. Thus the reaction is in reality a combination of sulphuric acid and common salt, with the application of gentle heat in the resulting production of sodium sulphate Na_2SO_4, and hydrochloric acid, 2 HCl.

"Both of these products have a commercial value. The sodium sulphate is known as Glauber's salts, and the market for this is somewhat restricted. The hydrochloric acid exists in the form of a gas and requires condensation by water. The latter absorbs the hydrochloric acid gas in quantities such that the resulting product consists of 43 per cent of water. The value of hydrochloric acid is considerably greater than that of sulphuric acid, and the weight of the resulting product in this form, per ton of sulphur used, is much less, since from the molecular weights of the two materials alone, their relative weights can be determined in the ratio of 36 to 100, and about equal volumes of water are used in the two cases, so that the weight of the resulting commercial product in the two cases is in the ratio of 1 to 3, if they each combine with their own weight of water. Glauber's salts could be shipped to market and a profit obtained when the freight rates and the conditions of the market were such as to warrant this development. Under other circumstances it could be thrown out on the waste pile and would be unobjectionable, since fairly stable in constitution. The hydrochloric acid would find a ready market at prices which would allow a distinct profit, even at considerably higher freight rates than now exist, and the solution of the problem could be readily accomplished by this means.

"This represents only one of the possible available utilizations of sulphuric acid in the solution of this particular problem, but it seems quite sufficient to meet the requirements of the situation. The sulphur dioxide would be removed from the atmosphere and rendered harmless. By-products would be obtained in another form, which would have a ready sale and considerable value. The utilization of mechanical refrigeration and the decomposition of the sulphur dioxide are apparently unavailable on account of limitations in the development of mechanical refrigeration, on account of the great heat of decomposition of sulphur dioxide. The solution of this and many similar problems in the utilization of by-products, is undoubtedly based upon chemical reactions, and considerable knowledge and profit would undoubtedly be obtained in the operation of the average smelter by a thorough study of this field and its possibilities."

THE ENGINEERING INDEX

"THE KEYSTONE IN-THE-ARCH-OF-APPLIED-SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A New Arch Curve, the Parabolic Oval. Charles Worthington. Gives a description illustrating the derivation of the curve, and some examples of its application, with working equations. 2500 w. Eng News—April 15, 1909. No. 3979.

See also Concrete, under BRIDGES.

Bascule.

Different Erection Methods for Scherzer Lift Spans. Illustrates and describes work in connection with improvements on the N. Y., N. H. & H. R. R. The Baychester bridge and the Bronx River bridge, both of the Scherzer type. 1000 w. Eng Rec—April 3, 1909. No. 3707.

Concrete.

Concrete Bridge Specifications. T. H. McDonald. Read before the Iowa Assn. of Cement Users. Discusses the requirements of such specifications. 1200 w. Cement Age—April, 1909. No. 4079.

Concrete in Arched Bridge Construction. E. P. Wells. Lecture at the Concrete Institute on the construction of such bridges, with abstract of its discussion. 4000 w. Builder—April 3, 1909. No. 3887 B.

See also Culverts, under BRIDGES; and

We supply copies of these articles. See page 483.

Grade Reduction, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Culverts.

Building Concrete Culverts in Freezing Weather. J. H. Ryckman. Describes work on the Canadian Northern Quebec Ry. 800 w. Eng Rec—April 17, 1909. No. 4013.

Manhattan.

Erection of the Suspended Superstructure of the Manhattan Bridge, New York. Describes the general arrangement of the plant, and the methods used. 1800 w. Eng Rec—April 3, 1909. No. 3698.

The Queensboro and Manhattan Bridges Across the East River. Illustrated article dealing with the opening of the Queensboro bridge and work of completing the Manhattan bridge. 1200 w. Sci Am—April 10, 1909. No. 3839.

Piers.

The Construction of the River Piers of the Pierre Bridge. Illustrated description of work in South Dakota, on a river subject to floods. 2500 w. Eng Rec—April 3, 1909. No. 3710.

Reinforced Concrete.

A Criticism of the Reinforced-Concrete Bridge Truss. Editorial. 1200 w. Eng News—April 22, 1909. No. 4163.

Costs of Reinforced Concrete Bridges. Especially with Regard to Maintenance. E. P. Goodrich. Extracts from a paper read at the Cleveland convention of the Nat. Assn. of Cement Users. 1500 w. Cement Age—April, 1909. No. 4078.

The Application of Spiral Hooping to a French Concrete Bridge. Illustrates and describes details of a bridge at Avranches, France. 700 w. Eng News—April 22, 1909. No. 4162.

Contractors' Plant on the Connecticut Avenue Bridge, Washington. An outline of the principal plant and operations and the complete location plan. The cost of the falsework was about $50,000. 2500 w. Eng Rec—April 3, 1909. No. 3705.

The Market House Bridge at Monterrey, Mexico. Lloyd B. Smith. Illustrated description of a reinforced concrete bridge carrying an arcade of stores. 1000 w. Eng News—April 8, 1909. No. 3849.

The Mississippi River Boulevard Bridge at St. Paul. Illustrated description of a reinforced-concrete structure. 1200 w. Eng Rec—April 3, 1909. No. 3704.

The Grand River Bridge of the Lake Shore & Michigan Southern Railway. Illustrated description of a recently completed four-track, reinforced-concrete arch bridge. 3000 w. Eng Rec—April 24, 1909. No. 4167.

See also Trestles, and Viaducts, under BRIDGES.

Replacement.

Erection of Delaware River Bridge at Portland, Pennsylvania. Illustrated description of methods used in replacing an entire steel superstructure, on the old substructure, without interrupting traffic on a single-track bridge. 4000 w. Eng Rec—April, 1909. No. 3709.

Roller Bearings.

Provision for Expansion in Bridges (Notes sur les Appareils de Dilatation des Ponts). A. Nachtergal. Discusses the theoretical considerations in providing for expansion, and the types of bearings used. Ills. 2800 w. All Indus—March, 1909. No. 4228 D.

Steel.

The Theory of Secondary Stresses in Trusses. John H. Griffith. Gives a suggested method of computation for Manderla's problem. 6000 w. Mich Tech—Feb., 1909. No. 4072 D.

The Erection of Girder Bridges. Frank W. Skinner. An illustrated article, the present number considering the handling girders at the shop, loading on cars, handling at bridge site, and examples of erection with derricks. 4500 w. Eng Rec—April 10, 1909. Serial, 1st part. No. 3863.

Steel Railroad Bridges. R. G. Manning. A discussion of present practice, dealing with location, type, loading, specifications, design, fabrication, inspection, transportation, erection and maintenance. General discussion follows. 8500 w. Pro Ry Club of Pittsburgh—Feb. 26, 1909. No. 3809 C.

The Erection of the Susquehanna River Bridge of the Baltimore and Ohio Railroad. Illustrated description of steel-truss bridge work at Aikin, Md. 3300 w. Eng Rec—April 3, 1909. No. 3719.

The Atlantic Avenue Bridge Extension, Boston. Illustrated detailed description of difficult work. 2500 w. Eng Rec—April 3, 1909. No. 3700.

See also Manhattan, Replacement, Roller Bearings, and Viaducts, under BRIDGES.

Trestles.

A Heavy Reinforced-Concrete Trestle. Illustrated description of a long, high structure at Youngstown, Ohio. 2000 w. Eng Rec—April 3, 1909. No. 3706.

Viaducts.

Erection of the Arches of the Mulberry Street Viaduct, Harrisburg. Illustrates and describes the construction of the arches and roadway system of this reinforced concrete structure. 3800 w. Eng Rec—April 3, 1909. No. 3690.

Difficult Erection of the Providence Viaduct. Illustrates and describes the construction of a steel viaduct about 1,200 ft. long, in connection with improvements by the N. Y., N. H. & H. R. R. 3800 w. Eng Rec—April 3, 1909. No. 3702.

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CONSTRUCTION.

Boring.

See Wells, under WATER SUPPLY.

Building Raising.

Raising Large Brick Buildings in Galveston, Texas. Describes methods used in raising St. Patrick's Church, and the Broadway School. Ills. 1200 w. Eng Rec—April 3, 1909. No. 3697.

Concrete.

Concrete—Its Aggregates and Mixing. William Challoner. Deals with conditions inseparable from the actual work, limiting the discussion to coarser component parts of concrete. General discussion. 8500 w. Surveyor—April 2, 1909. No. 3900 A.

Practical Methods of Concrete Construction. C. G. Cline. Brief account of things needing care in concrete construction. 2000 w. Ap Sci—March, 1909. No. 4093 C.

Hints for Inspectors of Concrete Work. The first of a series of articles discussing the more important duties of inspectors. 1800 w. Engng-Con—March 31, 1909. Serial, 1st part. No. 3680.

Artistic and Commercially Practical Surface Finishes for Concrete Work. J. H. Chubb. Illustrated article showing what can be accomplished in the way of producing pleasing surface finishes for concrete work. 2200 w. Eng Rec—April 3, 1909. No. 3708.

Concrete Construction for Gun Battery. Illustrated detailed description of work. 2500 w. Cement—March, 1909. No. 3925 C.

See also Contractor's Plant, Regulations, and Tunnels, under CONSTRUCTION; Sidewalks, under MUNICIPAL; and Shafts, under MINING AND METALLURGY, MINING.

Contractor's Plants.

A Concrete Plant for Rapid Building Construction. Illustrated detailed description of the plant for a concrete building at East Norwood, Ohio. 1500 w. Engng-Con—April 21, 1909. No. 4151.

See also Reinforced Concrete, under BRIDGES; and Dams, under WATER SUPPLY.

Cost Keeping.

A Cost Record System Used for Work Done by Day Labor. Describes a special cost account system devised by C. S. Keating for work in Grand Rapids, Mich. 1800 w. Eng News—April 8, 1909. No. 3853.

Domes.

The Schwedler Dome, Loads and Stresses. A. P. Mills. A mathematical discussion of dead load and wind load stresses. Diagrams. 3500 w. Mich Tech—Feb., 1909. No. 4070 D.

Earthquake.

Earthquakes (Les Tremblements de Terre). E. Lemaire. A discussion of construction to withstand earthquake shocks with reference to the disaster at Messina. Ills. Serial, 1st part. 7000 w. Génie Civil—March 6, 1909. No. 4233 D.

The Employment of Reinforced Concrete in Localities Subject to Earthquakes (Pensieri sull' Impiego del Cemento armato in Località soggette a terremoti). C. Caveglia. A general discussion of the applicabiilty of this material to structures in earthquake countries. 3200 w. Ann d Soc d Ing e d Arch Ital—March 15, 1909. No. 4242 F.

Earthquake Construction in Reinforced Concrete (Costruzioni antisismiche in Cemento armato, resistenti ai più forti Terremoti). G. Marrucchi and A. Bruttini. A mathematical discussion of the design of concrete structures to withstand earthquake shocks. Ills. 4500 w. Ann d Soc d Ing e d Arch Ital—March, 1909. No. 4243 F.

Foundations to Withstand Earthquakes (La Fondazioni asismiche). M. Viscardini. Describes the system patented by the author. 3000 w. Monit Tech—March 30, 1909. No. 4290 D.

Excavation.

Plowing as a Means of Classifying Excavation. Gives the opinion of the Indiana Supreme Court on this subject as rendered in a recent case. 4000 w. Eng Rec—April 10, 1909. No. 3860.

See also Barge Canal, under WATERWAYS AND HARBORS; and Drills, under MINING AND METALLURGY, MINING.

Failures.

See Tanks, under WATER SUPPLY.

Foundations.

Foundations for Addition to Manhattan Life Building, New York City. T. Kennard Thomson. Illustrated description of methods used on a difficult site. 6000 w. Can Soc of Civ Engrs—March 11, 1909. No. 4319 N.

The Design of Continuous Foundations in Reinforced Concrete (Contributo al Calcolo delle Fondazioni continue in Cemento armato). A. Danusso. Mathematical and theoretical. Ills. Serial, 1st part. 4500 w. Il Cemento—Feb. 15, 1909. No. 4245 D.

See also Earthquake, and Underpinning, under CONSTRUCTION.

Frame Buildings.

Methods and Cost of Constructing Frame Cottages and Service Buildings for the Camaguey, Cuba, Waterworks. Henry A. Young. Describes buildings and gives details of costs. 3000 w. Engng-Con—April 14, 1909. No. 3976.

Hydraulic Filling.

See Dams, under WATER SUPPLY.

Piles.

Bearing Power of Piles. M. C. Hendry. A discussion of this subject, giving

opinions of experts. Ills. 6500 w. Can Engr—April 9, 1909. No. 3877.

See also Stations, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Reclamation.

See Coast Protection, under WATERWAYS AND HARBORS.

Regulations.

Regulations for the Planning, Execution and Testing of Concrete Structures. Gives the regulations adopted for Germany. 1500 w. Cement—March, 1909. No. 3923 C.

Draft of Regulations for Concrete Construction (Concept-Betonijzer-voorschriften). The text of the regulations proposed by the Dutch Institute of Engineers. 4800 w. De Ingenieur—March 20, 1909. No. 4375 D.

Reinforced Concrete.

Some Practical Ideas on Reinforced Concrete Design. Ernest McCullough. A talk before the Civ. Engng. Soc. of Armour Inst. on some things not mentioned in current treatise, such as deflection, factor of safety, etc. 5400 w. Engng-Con—April 14, 1909. No. 3973.

Reinforced Concrete T-Beam Tables. J. Norman Jensen. Gives a table for determining the area of steel and width of reinforced concrete T-beams, explaining its preparation. 2000 w. Eng Rec—April 10, 1909. No. 3864.

Evolution of Concrete Reinforcement Harry Franklin Porter. Read before the Nat. Assn. of Cement Users. Considers the development of steel reinforcement. 3300 w. Cement—March, 1909. No. 3924 C.

Unit Costs of Reinforced Concrete Building Construction. T. Herbert Files. Deals with labor costs only. 1200 w. Engng-Con—April 7, 1909. No. 3870.

The Practical Side of Reinforced Concrete Building. Vere Sussex Hyde. Illustrates and describes details of construction of importance for safety. 2000 w. Prac Engr—April 9, 1909. Serial, 1st part. No. 3992 A.

The Cummins Station Warehouse. Nashville, Tennessee. A reinforced-concrete frame, floors and roof, with outside walls of brick. Ills. 2500 w. Eng Rec—April 24, 1909. No. 4171.

The Reconstruction in Reinforced Concrete of the Large Manufacturing Plant of J. B. King & Co., Staten Island, N. Y. Arthur G. Hoadley. Illustrated detailed description of interesting methods. 3500 w. Eng News—April 22, 1909. No. 4161.

Construction of the Baxter Building, Portland, Maine. Illustrated description of methods used for a reinforced concrete frame with flat-slab reinforced concrete floors and brick walls. 1300 w. Eng Rec—April 10, 1909. No. 3862.

Bank of Nova Scotia, Kingston, Jamaica. Robert T. H. Sailman. Describes points of interest in the design and construction of a building aiming to be fireproof and secure against damage by earthquake. 3000 w. Can Engr—April 16, 1909. No. 3995.

The General Post-Office Extension. Illustrated detailed description of an important reinforced concrete construction in London. 2800 w. Builder—April 3, 1909. Serial, 1st part. No. 3886 A.

A Concrete Foundry Building in Germany. H. Prime Kieffer. Illustrated description of a simple, inexpensive and thoroughly fireproof reinforced-concrete structure. 1000 w. Cement Age—April, 1909. Serial, 1st part. No. 4081.

Reinforced-Concrete Construction in the Enlargement of the Oberlenningen Paper Mill (Die Eisenbetonkonstruktionen in den Erweiterungsbauten der Papierfabrik Oberlenningen, Württemberg). Illustrated description of heavy factory construction. 2800 w. Beton u Eisen—March 10, 1909. No. 4283 F.

See also Earthquake, Foundations, Regulations, and Retaining Walls, under CONSTRUCTION; Dams and Purification, under WATER SUPPLY; Docks, Jetties, and Sea Walls, under WATERWAYS AND HARBORS; Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS; Poles, under ELECTRICAL ENGINEERING, TRANSMISSION; Timbering, under MINING AND METALLURGY, MINING; and Stations, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

A Large Concrete Retaining Wall. Illustrated detailed description of harbor work in Pittsburg. 2500 w. Eng Rec—April, 1909. No. 3689.

Stacks.

A Steel Chimney. Gives points in favor of such chimneys, illustrating a recent type. 800 w. Ir & Coal Trds Rev—April 2, 1909. No. 3915 A.

Steel.

See Domes, under CONSTRUCTION; and Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Tanks.

Reservoirs for Petroleum Dregs for Rumanian State Railways. From *Revue Gen. des Chemins de fer.* Illustration and brief description of novel storage tanks. 500 w. R R Age Gaz—April 23, 1909. No. 4156.

Tunnel Lining.

Injection of Cement Grout in the Col des Montets Tunnel on the Line from Fayet to the Swiss Frontier (Note sur les Injections de Ciment pratiquées dans le Souterrain du Col des Montets, Haute-

Savoie, sur la Ligne du Fayet à la Frontière suisse). E. Nivert. Describes the apparatus and methods. Ills. 5000 w. Rev Gen des Chemins de Fer—March, 1909. No. 4219 G.

Tunnels.

Tunnel Driving Records. R. L. Herrick. A comparison of methods and speeds in America with other countries. 5500 w. Mines & Min—April, 1909. No. 3675 C.

Driving Headings in Rock Tunnels. W. L. Saunders. Deals especially with heading-driving, and gives tunneling records for America and Europe, describing methods and machines. Ills. 8500 w. Bul Am Inst of Min Engrs—April, 1909. No. 4084 F.

Methods and Cost of Tunneling on the Alaska Central Railway. Compiled from a paper by G. A. Kyle, read before the Pacific North-West Society of Engrs. 3500 w. Engng-Con—April 7, 1909. No. 3873.

The Gunnison Tunnel. Frank A. Newton. Describes work in connection with the irrigation system of the Uncompahgre Valley Project in the arid regions of the west. Ills. 1600 w. Wis Engr—Feb., 1909. No. 4317 D.

Roosevelt Tunnel. R. L. Herrick. Describes the successful system of driving a tunnel through unusually hard rock, after it had been given up by three contractors. Ills. 5500 w. Mines & Min—April, 1909. No. 3670 C.

Plant for Constructing a Concrete Tunnel Roadbed. Describes methods of construction used on the second Bergen Hill tunnel, by the D. L. & W. R. R., at Hoboken, N. J. 1700 w. Eng Rec—April, 1909. No. 3693.

Underpinning.

Underpinning the Homeopathic Hospital, Pittsburg Explains conditions, and describes methods of underpinning this large brick building while making the necessary repairs. Ills. 1200 w. Eng Rec—April 3, 1909. No. 3696.

The Knickerbocker Trust Building Substructure. Describes and illustrates interesting details in the method of protecting an adjacent structure, while erecting a 22-story steel cage office building on soil consisting of quicksand underlaid with a stratum of hardpan. 4000 w. Eng Rec—April 24, 1909. No. 4169.

Waterproofing.

Waterproofing—An Engineering Problem. Myron H. Lewis. Explains the meaning of the term in its broad sense, and the importance to engineers, discusses the design of waterproof systems, and related subjects. Discussion. 16000 w. Pro Engrs' Club of Phila—Oct., 1908. No. 4324 D.

MATERIALS OF CONSTRUCTION.

Brick.

Tests of Brick Columns and Terra Cotta Block Columns. Arthur N. Talbot and Duff A. Abrams. Describes tests made of 16 short columns of brick and 16 columns built of terra cotta blocks. Ills. 11000 w. Univ of Ills, Bul No. 27—Sept. 29, 1908. No. 3808 N.

Cement.

Portland Cement for Use in the Tropics. Richard K. Meade. Reviews an article on Portland Cement Testing which appeared in "The Philippine Journal of Science," of June, 1908, combating the attempt to show that a special cement is demanded for use in the tropics. 2500 w. Eng News—April 8, 1909. No. 3850.

The Behavior of Cement towards Liquids and Metals (Das Verhalten des Zements gegen Flüssigkeiten und Metalle). Dr. Rohland. A discussion of the chemistry of hardening in hydraulic cements. 3000 w. Zeitschr d Oest Ing u Arch Ver—March 19, 1909. No. 4280 D.

Cement Blocks.

The Present and Future of the Cement Block. J. Augustine Smith. Extracts from a paper read before the Nat. Assn. of Cement Users. Reviews the development of this material and considers the outlook promising. 3500 w. Cement Age—April, 1909. No. 4080.

Paving Brick.

Improvement in Manufacture of Paving Brick. Diagrams and description of the Dunn Cutting device. 2000 w. Contract Rec—April 14, 1909. No. 4016.

Reinforced Concrete.

Electrolysis of Reinforced Concrete. A. S. Langsdorf. Describes experiments made to determine the electrolytic behavior of reinforced concrete. Ills. 1000 w. Jour Assn of Engng Socs—Feb., 1909. No. 3961 C.

The Corrosion of Steel Reinforcement in Concrete. Ernest R. Matthews. Describes experiments in connection with the rusting of steel in concrete, explaining in detail the tests made by the writer, and stating conclusions. 4500 w. Soc of Engrs—April 5, 1909. No. 4002 N.

A Test of Three Large Reinforced Concrete Beams. Arthur N. Talbot. Describes the slabs and method of testing, and gives data. Ills. 5000 w. Univ of Ills, Bul 28—Oct. 5, 1909. No. 3931 N.

Steel.

Tests of Built-Up Steel and Wrought-Iron Compression Pieces. Arthur N. Talbot and Herbert F. Moore. Describes tests giving observations on the results. Ills. 9800 w. Pro Am Soc of Civ Engrs—April, 1909. No. 4335 E.

Terra Cotta.

See Brick, under MATERIALS OF CONSTRUCTION.

We supply copies of these articles. See page 483.

Timber.

Afforestation and Timber-Planting in Great Britain and Ireland. Dr. J. Nisbet. Reviews the work of British Commissions appointed to deal with this question, explains the present situation, and discusses the possibilities. General discussion. 10000 w. Jour Soc of Arts—March 26, 1909. No. 3771 A.

Timber Preservation.

The Preservative Treatment of Timbers Used by Electric Traction Companies. J. M. Nelson. Read at meeting of Cent. Elec. Ry. Assn. Considers the causes of decay and the principles of its prevention, illustrating wood-preserving plants. 3500 w. Elec Ry Jour—April 3, 1909. No. 3668.

The Strength of Treated Mine Timbers (Ueber die Eigenschaften imprägnierter Grubenhölzer, insbesondere über ihre Festigkeit). D. Stens. Gives results of tests on various woods treated with various preservatives. 4200 w. Glückauf—March 6, 1909. No. 4261 D.

MEASUREMENT.

Current Meter.

Current Meter Rating. Francis C. Shenehon. Describes the calibration or rating of the current measuring instrument or meter. Ills. 4500 w. Minn Engr—March, 1909. No. 4061 C.

Datum Plane.

The Datum Plane. Otto Klotz. Discusses the subject from the points of view of the intellectual datum plane and the physical datum plane, referring to specific work depending on it. 7500 w. Pro Soc of Ap Sci—Session 1908-1909. No. 4094 C.

Latitude.

The Determination of Latitude. L. B. Stewart. Brief account of the principal methods which are adapted to the use of the surveyor's transit or the sextant, with brief reference to precise methods. 4000 w. Ap Sci—March, 1909. No. 4090 C.

Mensuration.

Volumes of Segments Cut from Cones: A Problem in Estimating Storage Piles. Charles A. Gilchrist. Mathematical. 1000 w. Eng News—April 29, 1909. No. 4357.

Surveying.

Some Extensive Railroad Surveys and Their Cost per Mile. W. S. McFetridge. Gives an outline of methods and results, and the cost of surveys in West Virginia and Ohio. Maps. 5800 w. Pro Am Soc of Civ Engrs—April, 1909. No. 4334 E.

MUNICIPAL.

Pavements.

The Construction of an Asphalt Street. Isaac Van Trump. From an address at the Univ. of Notre Dame, Ind. Describes the methods of construction. 1500 w. Munic Engng—April, 1909. No. 3819 C.

See also Paving Brick, under MATERIALS OF CONSTRUCTION.

Refuse Disposal.

The Design and Working of a Modern Destructor. William F. Loveday. Read before the Incor. Assn. of Munic. and Co. Engrs. Considers recent development and progress, giving the working and results. General discussion. 7500 w. Surveyor—April 9, 1909. No. 4027 A.

Electricity Works and Refuse Destructors. J. A. Robertson. Abstract of paper before the Glasgow Sec. Aims to show the benefits from the combination of electricity works and refuse destructors under certain conditions. 4000 w. Elec Engr, Lond—April 16, 1909. No. 4190 A.

Specifications and Bids for an Incinerating and Power Generating Plant for Milwaukee, Wis. Information in regard to this plant, with specifications and editorial. 4500 w. Eng News—April 22, 1909. No. 4164.

The Utilization and Disposal of Destructor Clinker. E. R. Sutcliffe. Gives suggestions as to how this material may be disposed of to the best advantage. Ills. 3000 w. Surveyor—March 26, 1909. No. 3781 A.

Roads.

Concave v. Convex Roads. Harold Turner. Examines the advantages and disadvantages of both formations. 2500 w. Surveyor—April 16, 1909. No. 4197 A.

The Theory of Economical Road and Street Design. Begins a study of the scientific method of designing a road. 1200 w. Engng-Con—April 14, 1909. Serial. 1st part. No. 3974.

The Top Soil Method of Highway Construction. C. M. Strahan. Gives methods and details of construction as applied in Georgia, reporting satisfactory results. 2000 w. Eng Rec—April 24, 1909. No. 4173.

French Roads and Roadmaking. Francis Miltoun. Information of interest, as France is noted for excellent roads. Ills. 2200 w. Autocar—April 3, 1909. Serial. 1st part. No. 3893 A.

The Use of Tar, Oils and Emulsions on Macadam and Earth Roads. A. R. Hirst. Abstract of a paper before the Soc. of Wis. Engrs. Brief description of methods of dust prevention and wear. 2200 w. Engng-Con—April 14, 1909. No. 3975.

Sewage Disposal.

Proposed Method of Discharging Sewage from the Passaic Valley Into New York Bay. Descriptive. 900 w. Eng Rec—April 10, 1909. No. 3865.

Sewage Purification Works at Mt. Vernon, N. Y. George L. Robinson. Illustrates and describes features incident to the location of sewage-treatment works near a built-up section of the city. 1700 w. Engng News—April 29, 1909. No. 4361.

Sewers.

Planning the Clinton Sewers. C. P.

Chase. From a paper before the Iowa Soc. of Engrs. An account of the surveys made and statistics gathered for planning a sewer system. 1700 w. Munic Engng—April, 1909. No. 3818 C.

Sewerage and Drainage Improvements at Cairo, Illinois. Illustrates and describes sewers for a city at the junction of the Ohio and Mississippi rivers, and so needing protection from floods. 1800 w. Eng Rec—April 17, 1909. No. 4014.

Sidewalks.

Failures in Concrete Sidewalks and How to Correct Them. L. J. Riegler. From a report to the Pennsylvania Co. An illustrated study of causes and remedies. Also standard specifications of the Nat. Assn. of Cement Users. 3500 w. Eng News—April 1, 1909. No. 3757.

WATER SUPPLY.

Aqueducts.

Construction Work on the Los Angeles Aqueduct. E. W. Bannister. Brief outline of the project and description of the aqueduct, illustrating and describing the progress made in 1908. 4500 w. Eng Rec—April 3, 1909. No. 3699.

Artesian Waters.

The Brown Artesian Waters of Costilla County, Colo., their Relations to Certain Deposits of Natron or Soda, and What They Teach. William P. Headden. A study of a basin yielding brown waters, surrounded by a supply of colorless water. 4000 w. Am Jour of Sci—April, 1909. No. 3804 D.

Dams.

Concerning the Gatun Dam and Earth Dams in General. An illustrated explanation of conditions and construction details at Gatun, and a study of the principles of earth dam design. 5000 w. Eng News—April 1, 1909. No. 3761.

Hydraulic Dam Construction on the Conconully Dam, Washington. D. C. Henry. Describes the experience and difficulties met in constructing by the hydraulic process this earth fill dam located in Washington and forming a part of the Okanogan project. Ills. 4500 w. Eng Rec—April 3, 1909. No. 3687.

The Arrowhead Hydraulic Fill Dam. F. C. Finkle. Illustrated description of the construction in California of the highest earth dam in the world. 1800 w. Eng Rec—April 3, 1909. No. 3716.

The Undermining of a Reinforced-Concrete Dam at Pittsfield, Mass. Gives drawings and points of engineering interest in the undermining of the Ashley dam, and the possible methods of repair. 3000 w. Eng News—April 1, 1909. No. 3758.

The Pipen Brook Dam. Illustrated description of a concrete dam near Stanwich, Conn. 1000 w. Eng Rec—April 3, 1909. No. 3695.

The Construction Work of the New Dam of the Bellows Falls Canal Company. Howard S. Knowlton. Describes plan and construction of a concrete dam across the Connecticut River. Ills. 2500 w. Eng Rec—April 3, 1909. No. 3718.

The La Prele Dam. Illustrated description of an open-front hollow reinforced-concrete dam being constructed as a part of an irrigation project in Wyoming. 2000 w. Eng Rec—April 3, 1909. No. 3688.

The Olive Bridge Dam Concrete Plant. Illustrated description of the plant installed for the construction of this dam for the Ashokan reservoir in the Catskill Mts. It will be one of the largest and highest masonry dams in the world. 2000 w. Eng Rec—April 3, 1909. No. 3691.

See also Barge Canal, under WATERWAYS AND HARBORS.

Flume Gaging.

An Approximate Method for Flume Gaging. Henry J. Kesner. The discussion is limited to an adaptation of the methods outlined to the case of rectangular flumes. 2000 w. Minn Engr—March, 1909. No. 4066 C.

Ground Waters.

Detecting Underground Streams with an Ear-Trumpet. Illustrated description of a new apparatus based on the principle of the "acoustele." 800 w. Sci Am—April 10, 1909. No. 3837.

Intakes.

See Pipe Lines, under WATER SUPPLY; and Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Irrigation.

Irrigation Works in the Hawaiian Islands. M. M. O'Shaughnessy. An illustrated account of the extensive development of irrigation projects to furnish water for the sugar-cane lands. 5000 w. Eng News—April 15, 1909. No. 3977.

See also Tunnels, under CONSTRUCTION; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Pipe Lines.

The Construction of the Submerged Intake of the Gary, Indiana, Water Works. Illustrated detailed description of unusual methods used in constructing this intake in Lake Michigan. 3500 w. Eng Rec—April 10, 1909. No. 3857.

Laying Submerged Pipe for the Fort Greble Water Supply. Illustrated description of work in Narragansett Bay. 2000 w. Eng Rec—April 3, 1909. No. 3692.

Constructing a Line of Steel Pipe, 12½ Feet in Diameter. Illustrated description of methods of constructing a pipe line for the hydro-electric plant of the Schenectady Power Co. 2200 w. Eng Rec—April 3, 1909. No. 3701.

Pipes.

The Strength of Oval Pipes under Internal or External Fluid Pressure (Festigheit von ovalen Röhren gegen inneren oder äusseren Flüssigkeitsdruck). M. Westphal and J. Schmidt. Two short mathematical notes. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—March 6, 1909. No. 4292 D.

Purification.

The Storage of Raw River Water. Information from the third report of Dr. A. C. Houston to the Metropolitan Water Board, giving results. 1800 w. Engr, Lond—April 9, 1909. No. 4038 A.

The Construction of the Water Purification and Softening Works at New Orleans. Illustrated description of a plant for purifying the Mississippi River water, largely constructed of reinforced concrete. 5800 w. Eng Rec—April 3, 1909. No. 3715.

Reservoirs.

The New Croton Falls Reservoirs. Illustrates and describes interesting details in connection with the 15-billion gallon reservoir for the supply of New York City. 1200 w. Sci Am—May 1, 1909. No. 4329.

Tanks.

Failure of Two Iron Water Tanks at Parkersburg, W. Va. William M. Hall. Brief illustrated description of the failure on March 19, 1909. 2000 w. Eng News—April 1, 1909. No. 3760.

Typhoid Fever.

See Washington, D. C., under WATER SUPPLY.

Vancouver.

A New Water-Supply for the City of Vancouver, B. C. H. M. Burwell. Illustrated description of the chief features of the Seymour Creek system, now nearing completion. 3000 w. Eng News—April 1, 1909. No. 3756.

Washington, D. C.

Sedimentation of the Water Supply and Its Relation to Typhoid Fever in Washington, D. C. Francis F. Longley. A statement of new facts bearing upon this subject. 4000 w. Eng News—April 22, 1909. No. 4160.

Water Meters.

Water Meters. J. J. Traill. Illustrates and describes types. 1500 w. Ap Sci—March, 1909. No. 4092 C.

Water Works.

New Bedford Water Works. Interesting information from the annual report for 1908. Ills. 2800 w. Munic Jour & Engr—April 7, 1909. No. 3795.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Water-Works Valuation.

The Valuation for City Purchase of the Property of the Waterloo (Ia.) Water-Works Co. A. Marston. General explanation with abstract of explanatory report. 1600 w. Eng News—April 22, 1909. No. 4158.

Wells.

Methods of Deep Well Drilling in the Gulf of Mexico Costal Plain. Illustrates and describes a number of methods used. 1500 w. Engng-Con—April 7, 1909. No. 3871.

WATERWAYS AND HARBORS.

Barge Canal.

The New York Barge Canal. Theron M. Ripley. Brief review of the history and progress of this project. Ills. 4000 w. Jour Assn of Engng Socs—Feb., 1909. No. 3963 C.

Construction Work on the New York State Barge Canal. Illustrated description of work on a number of contracts, the dredging and excavating equipment, methods, dams, locks, etc. 19600 w. Eng Rec—April 3, 1909. No. 3712.

Chicago.

The Engineering, Commercial and Administrative Problems of Harbor Development at Chicago. Editorial review of report of a commission to investigate the facilities and the relations of the harbor to the railway terminals. 3500 w. Eng News—April 29, 1909. No. 4363.

Coast Protection.

Reclamation and Development of the New Jersey Coast. George L. Watson. Describes reclamation of meadowland and beach protection at Five Mile Beach, New Jersey. Ills. 2500 w. Can Soc of Civ Engrs—April 15, 1909. No. 4320 N.

Cofferdams.

The Black Rock Lock Cofferdam. Illustrates and describes the construction at Buffalo, N. Y., of an unbraced steel and puddle cofferdam in which a concrete ship lock will be constructed. 2200 w. Eng Rec—April 3, 1909. No. 3694.

Colorado River.

The Colorado River Breach and Closure.. An illustrated account of the break in 1906, that flooded the Salton Basin, and the attempts and final success in closing it. 2500 w. Engr, Lond—April 9, 1909. No. 4037 A.

Detroit River.

Progress on the Improvement of the Detroit River. Describes the work of increasing the channel depth, the methods employed, etc. 5700 w. Eng Rec—April 3, 1909. No. 3703.

Docks.

A Heavy Concrete Dock on the Cuyahoga River, Cleveland. Explains conditions and illustrates and describes the dock. 1500 w. Eng Rec—April 3, 1909. No. 3711.

Dredging.

See Barge Canal, under WATERWAYS AND HARBORS.

We supply copies of these articles. See page 483.

Dry Docks.

Floating or Stationary Dry Docks (Schwimmdock oder Trockendock). Herr Thalenhorst. A discussion of their relative advantages in various situations. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—March 27, 1909. No. 4298 D.

Floods.

High-Water Marks. Francis W. Blackford. An illustrated account of destruction caused by unusually high water in Mexico. 700 w. Jour Assn of Engng Socs—Feb., 1909. No. 3964 C.

Harbors.

Some Experiences With Tides and Waves. H. A. Russell. Relates some experiences in building upon sands in harbor work. 3500 w. Can Engr—April 9, 1909. No. 3878.

Building a Harbor. Charles F. Holder. Remarks on the lack of safe harbors on the Californian Coast, with illustrated description of government work in progress at San Pedro. 1200 w. Int Marine Engng—April, 1909. No. 3683 C.

Ice Jams.

Extraordinary Ice Jams at Niagara Falls. An illustrated account of the unusual conditions in February and the blasting to break the glacier. Plate. 2800 w. Eng News—April 29, 1909. No. 4355.

Jetties.

A Complicated Reinforced Concrete Jetty-Head, Thames Haven, Eng. Views and short description. 700 w. Eng News—April 22, 1909. No. 4165.

Liverpool.

Barriers to International Trade. Lewis M. Haupt. An illustrated description of harbor problems at the port of Liverpool is given. A second paper will discuss the harbor of New York. 4000 w. Cassier's Mag—April, 1909. Serial. 1st part. No. 3639 B.

Locks.

See Barge Canal, under WATERWAYS AND HARBORS.

Missouri River.

The Missouri River and Its Bridges. J. Y. Oleson. Describes the characteristics of this river, and gives diagrams and dimensions of the 31 bridges crossing it. 1200 w. Eng News—April 29, 1909. No. 4358.

New York.

See Liverpool, under WATERWAYS AND HARBORS.

Niagara River.

Hydraulic Measurements in the American Channel at Niagara Falls. Otta S. Zelner. Deals with a study in the American channel of the conditions arising from water diversions above the Falls. Ills. 3500 w. Mich Tech—Feb., 1909. No. 4073 D.

Panama Canal.

The Situation at Panama. Forbes Lindsay. A review of the plan and conditions, sanitation, labor, etc. Ills. 3500 w. Am Rev of Rev—April, 1909. No. 3810 C.

The Panama Canal. James P. Stabler. A review of the various projects for building a ship canal across the Isthmus and some features of the present work. 3000 w. Mfrs Rec—April 8, 1909. No. 3822.

River Beds.

The Form of the Beds of Rivers with Shifting Bottoms (La Forma dell'Alves dei Fiumi a Fondo mobile). G. Crugnola. A discussion of M. L. Fargue's book on the subject. 3500 w. Monit Tech—March 10, 1909. No. 4244 D.

River Improvement.

The Improvement of the Southwest Pass at the Mouth of the Mississippi River. Illustrated description of the jetties built to increase the navigable depth. 3500 w. Eng Rec—April 3, 1909. No. 3713.

River Pollution.

River Pollution: Its Ethics, Aesthetics and Hygiene. A discussion at the Royal Sanitary Institute, opened by Mr. Scott-Moncrieff. 6000 w. Surveyor—April 16, 1909. No. 4198 A.

Sea Walls.

Construction of a Sea Wall at Fort Morgan, Alabama. Illustrated description of the new concrete wall protecting the entrance to Mobile Bay. 2500 w. Eng Rec—April 24, 1909. No. 4170.

Building a Sea Wall on a Sloping Rock Bottom. Illustrated description of bulkhead wall work on the East River at New York. 4500 w. Eng Rec—April 10, 1909. No. 3858.

Weirs.

An Investigation of the Coefficients of Discharge of Thin-Edged Weirs with Full End Contractions Discharging Water Under Low Heads. Hans von Vittinghoff, Victor von Starzenski, and W. Roland Wiley. Descriptive. Ills. 3000 w. Stevens Ind—Jan., 1909. No. 3812 D.

MISCELLANY.

Australia.

Engineering in Australia; Pioneering a Continent. Jas. Alex. Smith. Pres. address before the Victorian Inst. of Engrs. A critical discussion of the engineering administration. 2500 w. Aust Min Stand—March 17, 1909. Serial, 1st part. No. 4188 B.

Caisson Disease.

Caisson Disease and Its Prevention. Henry Japp. An account of methods tried during the building of the East River tunnels at New York City. Ills. 6000 w. Pro Am Soc of Civ Engrs—April, 1909. No. 4336 E.

History,

The Engineer's Work in the West, at an Early Day and During the Civil War.

We supply copies of these articles. See page 483.

Gen. Grenville M. Dodge. A review of the writer's experience previous to and during the Civil War, and in building the Union Pacific. 7000 w. Jour W Soc of Engrs—Feb., 1909. No. 3296 D.

Photography.

Engineering Photography. William Munson Christie. Discusses progress in photography in general and features of engineering photography. Ills. 2500 w. Eng Rec—April 3, 1909. No. 3717.

Tropics.

Suggestions for the Conduct of Engineering Work in the Tropics. Robert Burgess. Discusses the various phases of the labor problem and the methods and equipment. 6000 w. Eng News—March 11, 1909. No. 3101.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Directed Wireless Telegraphy. F. Kiebitz. Abstract trans. from *Ver. der Deutscher Phys, Gesellschaft.* Describes experiments. 1500 w. Elect'n, Lond—April 3, 1909. No. 3899 A.

Wireless Telegraphy in the American Republics. An illustrated review of progress. 3000 w. Bul Am Reps—April, 1909. No. 3930 N.

Radio-Telephony.

Wireless Telephony (La Téléphonie sans Fil). The first part discusses the general theory. Ills. Serial, 1st part. 2800 w. Génie Civil—March 13, 1909. No. 4235 D.

Wireless Telephony (La Téléphony sans Fil). C. Tissot. A general review of its history and present state. Ills. 6000 w. Tech Mod—March, 1909. No. 4229 D.

Telephone Exchanges.

The Automatic Telephone Central. Snowden B. Redfield. Describes new automatic apparatus and its operation. Ills. 4500 w. Am Mach—Vol. 32, No. 16. No. 4104.

DISTRIBUTION.

Current Rectifiers.

Recent Applications of the Mercury-Arc Rectifier. P. D. Wagoner. Explains the theory and describes some of the applications. Ills. 2000 w. Stevens Ind—Jan., 1909. No. 3813 D.

Insulation.

Insulating Materials. Thomas Germann and Stanley M. Hills. Abstract of a paper on "The Use of Dielectrics and the Principal Tests Applied to Them," read before the Jun. Inst. of Engrs. Examines the qualities of a good insulator and discusses some of the materials used. 3000 w. Mech Engr—April 9, 1909. No. 4030 A.

Wiring.

The Wiring Problem in Its Relation to Electricity Supply. Discusses present conditions in England, and the present wiring systems, suggesting improvements needed and describing recent systems tried. 3300 w. Elect'n, Lond—April 2, 1909. No. 3897 A.

Louisiana Electricians' Licensing Law. T. S. McLoughlin. A criticism and discussion of the 1908 State law licensing electricians. 2000 w. Elec Wld—April 15, 1909. No. 3945.

Wiring of the Babbitt Soap Factory at Babbitt, N. J. Illustrated detailed description of the wiring of a group of factory buildings for power and lighting. 1500 w. Elec Wld—April 1, 1909. No. 3750.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The E. M. F.s Induced in the Exciting Winding of Single-Phase Alternators. H. Brühn. Abstract from *Elektrotechnik und Maschinenbau.* Gives results of investigations showing that in addition to the e. m. f. which appears at the slip-rings other e. m. f.s exist inside the windings. 1500 w. Elect'n, Lond—April 16, 1909. No. 4196 A.

A. C. Motors.

Single-Phase Commutator Motors (Eenphase-wisselstroom-collectormotoren). C. Feldmann, K. H. Haga and C. Noome. A review of their theory and development and of present types. Ills. Serial, 1st part. 12400 w. De Ingenieur—March 20, 1909. No. 4376 D.

Automobile Motors.

See Electric, under MECHANICAL ENGINEERING, AUTOMOBILES.

Commutators.

The Performance of a Synchronous Commutator. J. B. Whitehead and L. O. Grondahl. An account of a series of experiments on a synchronously rotating commutator supplied, through collector rings, with alternating e. m. f. Ills. 4000 w. Elec Wld—April 15, 1909. No. 3944.

Condensers.

Condensers of Large Capacity (Kondensatoren groszer Kapazität). Günther Schulze. A discussion of their uses, construction and operation. Ills. 3200 w. Elektrotech u Maschinenbau—March 14, 1909. No. 4286 D.

D. C. Motors.

Reversing Direct-Current Machines. F. P. M'Dermott, Jr. Shows the application of some rules for studying these problems. 1600 w. Power—April 13, 1909. No. 3921.

Induction Motors.

The "Spinner" Induction Motor. Illus-

trates and describes this recent development in variable speed induction motors, giving some applications. 1500 w. Engr, Lond—April 9, 1909. No. 4041 A.

Investigation and Calculation of the Additional Iron Losses in Induction Motors. O. S. Bragsted and Fraenckel. Abstract trans. from *Elektrochemische Zeit.* Investigates the origin of these losses and deduces formulæ for calculating the same. 1500 w. Elect'n, Lond—April 2, 1909. No. 3898 A.

Railway Motors.

Faults on Tramcar Motors. Spencer Robinson. Deals with the most practical means of locating the faults and repairing the damage. 1500 w. Elec Rev, Lond—April 2, 1909. No. 3896 A.

Single Phase Railway Motors (Les Altermotours monophasés de Traction). M. Henry. An illustrated description of the various types, with details of the lines on which they are used. Serial, 1st part. 1500 w. Elecn—March 20, 1909. No. 4225 D.

ELECTRO-CHEMISTRY.

Calcium Carbide.

The Manufacture of Calcium Carbide. A detailed description of the calcium-carbide factory at Odda, Norway. Ills. 4000 w. Engng—March 26, 1909. Serial, 1st part. No. 3786 A.

Calcium Carbide (Le Carbure de Calcium). R. Pitaval. Discusses the economics of its manufacture. 2800 w. Génie Civil—March 27, 1909. No. 4237 D.

Calcium Cyanamide.

The Manufacture of Cyanamide in France and Its Use in Agriculture (La Cyanamide, la Fabrication française, son Role agricole). Ch. Pluvinage. A general review of manufacture, properties, and uses. Ill. 4000 w. Bul Soc d'Encour—March, 1909. No. 4218 G.

Corrosion.

The Protection of Iron and Steel from Corrosion. William H. Walker. A discussion of principles, conditions and remedies. Ills. 4000 w. Engineering Magazine—May, 1909. No. 4341 B.

See also Reinforced Concrete, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electro-Chemistry.

The Present State of Electro-Chemistry and Its Applications (Etat actuel de l'Electrochimie et de ses Applications). Octave Dony-Henault and Henri Gall. A general review of the applications of electro-chemistry. 11000 w. Rev d'Electrochim et d'Electrométal—Feb., 1909. No. 4211 F.

Electro-Metallurgy.

The Electric Furnace and Some of Its Applications. William Hoopes. Describes the electric furnace and its advantages, considering a number of applications. Ills. 4000 w. Elec Jour—April, 1909. No. 3951.

Electric and Fuel Furnaces. F. Louvrier. Considers the progress in the substitution of electrical energy, as a thermic agent, for the usual combustibles, coal, coke, petroleum, etc., and the causes. 2500 w. Elec-Chem & Met Ind—April, 1909. No. 3662 C.

Nitrogen.

The Fixation of Atmospheric Nitrogen by Electricity (La Nitrification de l'Air par Voie électrique). M. Dony. A general review of the various methods and the state of the industry. Ills. 6000 w. Soc Belge d'Elecns—March, 1909. No. 4206 E.

Reiew of 1908.

Electrochemistry in 1908. F. Mollwo Perkin. A review of progress in the electrochemical industries. 5000 w. Elect'n, Lond—March 26, 1909. No. 3780 A.

ELECTRO-PHYSICS.

Electrons.

The Constitution of Matter and of the Aether (Ueber die Konstitution der Materie und des Weltäthers). H. Strache. A brief statement of recent theories. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—March 19, 1909. No. 4279 D.

Heating.

The Heating of Electrical Resistances by Variable Currents (Die Ermittlung der Uebertemperaturen elektrischer Widerstände bei veränderlicher Strombelastung). C. Richter. A mathematical discussion of the effect of variability of current on the ordinary laws of heating. Ills. 3500 w. Elektrotech u Maschinenbau—March 21, 1909. No. 4288 D.

Permeability,

On the Permeabilities and the Reluctivities, for Very Wide Ranges of Excitation, of Normal Specimens of Compressed Steel, Bessemer Steel and Norway Iron Rods. B. Osgood Peirce. Describes a long series of determinations over a wide range of excitation, and considers especially a method of measurement in a massive yoke. Ills. 3000 w. Am Jour of Sci—April, 1909. No. 3803 D.

GENERATING STATIONS.

Central Stations.

Electrical Engineers and Gas Power. Philip W. Robson. Considers the application of gas engines to moderate-size generating stations. 2500 w. Elec Rev, Lond—March 26, 1909. No. 3778 A.

Gas-Producer Central Station at Harvard, Ill. Brief illustrated description. 1200 w. Elec Wld—April 15, 1909. No. 3943.

Municipal Plant at Marshfield, Wiscon-

sin. Louis B. Carl. Illustrated description of the electric-light plant and waterworks, and report of operating expenses. 1600 w. Power—April 20, 1909. No. 4047.

Power System of Louisville Lighting Co. Osborn Monnett. Illustrated description of a single-phase engine installation, remodeled into a two-phase turbine plant. 3500 w. Power—April 13, 1909. No. 3918.

Power Station of the Chicago, Lake Shore & South Bend Railway. Illustrated detailed description of the station and its equipment. 3500 w. Elec Ry Jour—April 17, 1909. No. 3968.

See Refuse Disposal, under CIVIL ENGINEERING, MUNICIPAL; and London, under STREET AND ELECTRIC STATIONS.

Costs.

Comparative Energy Costs in Two Central Stations. Gives comparative figures and discusses results. 1200 w. Elec Wld—April 1, 1909. No. 3753.

Germany.

German Central-Station Statistics and the Proposed Taxation of Electrical Service. Information of the growth, and the Government's reasons for the proposed taxation. 1200 w. Elec Wld—April 1, 1909. No. 3752.

Hydro-Electric.

The Early Construction Methods at the Plant of the Central Georgia Power Company. Illustrated description of work on an extensive development on the Ocmulgee River, Georgia. 3500 w. Eng Rec—April 17, 1909. No. 4011.

Development of the Rocky Creek Station of the Southern Power Company. Illustrated description of a development on the Catawba River. 6500 w. Eng Rec—April 3, 1909. No. 3720.

The Tennessee River Power Development at Hales Bar. Illustrates and describes work in progress near Chattanooga. 3500 w. Eng Rec—April 3, 1909. No. 3721.

The Construction of the Plant of the Connecticut River Power Company. George S. Hewins. Illustrated detailed description of engineering and concrete construction work. 3500 w. Eng Rec—April 3, 1909. No. 3714.

The Hydro-Electric Plant of the Wallkill River Company at Walden, N. Y. Harry W. Dennis. An illustrated description of the development of this small water-power. 3000 w. Cornell Civ Engr—April, 1909. No. 3949 C.

See also Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY; Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY; and Tin, under MINING AND METALLURGY, MINING.

Isolated Plants.

Isolated Plant vs. Central Station. A letter addressed to the Board of Estimate and Apportionment of New York City, by Percival Robert Moses, giving reasons why a private isolated plant should be installed in the New York public library. 2500 w. Power—April 27, 1909. No. 4311.

Switchboards.

Main Switchboard of Pratt Street Power Station, Baltimore. Illustrated description of the successful arrangement of a very complicated output. 2000 w. Elec Ry Jour—April 24, 1909. No. 4150.

LIGHTING.

Illumination.

Graphical Determination of the Illumination of Horizontal Plane Surfaces (Graphische Bestimmung der Beleuchtung horizontaler Bodenflächen). Robert Edler. A detailed description of the methods. 3200 w. Elektrotech u Maschinenbau—March 28, 1909. No. 4289 D.

Incandescent Lamps.

Tungsten Lamps Compared with Arc Lamps. Alton D. Adams. Advocating the use of tungsten lamps for street lighting. 2000 w. Munic Engng—April, 1909. No. 3817 C.

Street.

See Incandescent Lamps, under LIGHTING.

MEASUREMENT.

Dielectric Strength.

On Testing the Insulation Resistance of Live Cables on Direct-Current Systems. R. G. Allen. Abstract of paper before the Inst. of Elec. Engrs. at Dublin. An explanation of method used. 1200 w. Elec Rev, Lond—April 16, 1909. No. 4192 A.

Dynamo Testing.

The Testing of Electrical Machinery (La Prova delle Macchine elettriche). F. Loppe. The first part being a discussion of tests of the materials and construction of the machines. Serial. 1st part. 2500 w. Elettricita—March 25, 1909. No. 4240 D.

Galvanometers.

A Convenient Form of Galvanometer with Magnetic Shielding. E. F. Nichols and S. R. Williams. Abbreviated from *Phys Rev.* Detailed description. Diagram. 1500 w. Elect'n, Lond—April 9, 1909. No. 4026 A.

Laboratories.

The New Electric Laboratory Equipment of the City of Philadelphia. Illustrated description. 1500 w. Elec Rev, N Y—April 3, 1909. No. 3749.

The National Physical Laboratory in 1908. Editorial review of progress in all departments. 4000 w. Engng—March 26, 1909. Serial. 1st part. No. 3787 A.

We supply copies of these articles. See page 483.

Potentiometers.

The Use of the Potentiometer on Alternate-Current Circuits. Charles V. Drysdale. Discusses the application of the potentiometer principle to a. c. measurements and describes the use of the author's phase-shifting transformer with a potentiometer. 1200 w. Elect'n, Lond—April 16, 1909. No. 4194 A.

Resistance.

Non-Inductive, Water-Cooled Standard Resistances for Precision Alternating-Current Measurements. C. C. Patterson and E. H. Rayner. Abstract of paper to the Inst. of Elec. Engrs. Gives method of measuring resistances of low value and up to any current capacity. Ills. 2000 w. Elect'n, Lond—April 16, 1909. No. 4195 A.

Notes on Three Methods of Electrical Measurement (A propos de trois Méthodes de Mesures électriques). M. Bouffart. Discusses the measurement of the resistance of a galvanometer by the method of equal deviation, the e. m. f. of a cell by the Poggendorff method, and the internal resistance of a cell by the Mance method. Ills. 3500 w. Bul Sci de l'Assn des Eléves—Feb., 1909. No. 4205 D.

Units.

Notes on the Electromagnetic System (Quelques Réflexions au Sujet de Systéme électromagnétique). M. Pellat. A discussion of M. Berthelot's paper on systems of units. Ills. 2500 w. Bul Soc Int d Elecns—March, 1909. No. 4208 F.

POWER APPLICATIONS.

Hoisting.

See Electric Hoisting, under MINING AND METALLURGY, MINING.

Power Contracts.

Analysis of Proposed Change in Power Contract. Robert Sibley. Gives the proposed contract, showing that there is an increased expenditure due to unity power factor clause and peak load penalties. 2200 w. Eng & Min Jour—April 17, 1909. No. 4006.

Printing Presses.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

TRANSMISSION.

Cables.

See Dielectric Strength, under MEASUREMENT; and Insulation, under TRANSMISSION.

Grounding.

Grounding Secondaries. W. J. Canada. A review of the arguments for grounding and the principal objections raised. 4500 w. Elec Wld—April 1, 1909. No. 3751.

Insulation.

The Composition and Durability of Cable Papers. Clayton Beadle and Henry P. Stevens. Discusses the composition and durability of papers from the chemical point of view, in the present article. 4000 w. Elect'n, Lond—April 16, 1909. Serial. 1st part. No. 4193 A.

Lightning.

Attempts to Explain Globular Lightning (Les Tentatives d'Explication de la Foudre globulaire). C. de Jans. An exhaustive discussion of the phenomenon and the various theories suggested. 18800 w. Soc Belge d'Elecns—March, 1909. No. 4207 E.

Poles.

Concrete Poles (Betonmasten). Describes the Locher system and the cost, strength and economy of poles made by it. Ills. 2000 w. Beton u Eisen—March 10, 1909. No. 4284 F.

Protective Devices.

Storm and Lightning Protection to Line Wires. T. W. Poppe. Suggests the installation of a strong galvanized steel cable to protect the lines from falling branches. Ills. 1000 w. Elec Wld—April 1, 1909. No. 3755.

Transformers.

Recent Developments in Transforming Apparatus. H. W. Tobey. Read before the Schenectady Sec. of the Am. Inst. of Elec. Engrs. Describes and discusses recent devices. 6500 w. Pro Am Inst of Elec Engrs—April, 1909. No. 3958 F.

Three-Phase Transformer Connections and Resulting Voltages. A. D. Williams, Jr. Diagrams and explanatory notes. 1000 w. Power—April 20, 1909. No. 4049.

Oil Used in Electric Transformers. W. B. Kouwenhoven. Explains the purpose for which the oil is used, the care needed, and the qualities required. 2000 w. Ry & Loc Engng—April, 1909. No. 3657 C.

Troubles.

Principles of Fault-Location. Julius Bernstein. Condensed paper read before the Int. Assn. of Munic. Engrs. at Detroit. Describes the use of Wheatstone testing instruments. Diagrams. 4500 w. Sci Am Sup—May 1, 1909. No. 4332.

Method of Testing for Grounds or Short Circuits by Induction. W. H. Geiger. Describes methods. Diagrams. 2500 w. Sig Engr—April, 1909. No. 4001.

MISCELLANY.

Atmospheric Electricity.

Recent Observations in Atmospheric Electricity. P. H. Dike. A review of recent investigations by a number of experimenters. 5000 w. Am Jour of Sci—March, 1909. No. 2927 D.

Conversion Tables.

Horse-Power and Kilowatts. Gives tables for changing horse-power into watts and vice versa, with explanation. 1700 w. Power—April 20, 1909. No. 4051.

Electric Clocks.

The Present Status of Electric Clocks (Ueber den gegenwärtigen Stand der elektrischen Uhren). W. Krejza. A general review of types, applications, improve-

ments, etc. 3300 w. Elektrotech u Maschinenbau—Feb. 28, 1909. No. 3559 D.

Eiffel Tower Device for Showing Hour. Illustrated description of a novel incandescent lamp device and its system of operation. 1500 w. Sci Am Sup—April 24, 1909. No. 4114.

Electric Hygrometer.

An Electrical Method for the Measurement of the Amount of Moisture in Grain and Other Materials. Anthony Zeleny. Illustrated description of an instrument devised for rapidly and accurately determining the amount of moisture in corn. 1500 w. Minn Engr—March, 1909. No. 4064 C.

General Electric Co.

Pioneer Developments Within the General Electric Company. Dr. E. W. Rice, Jr. Read before the Schenectady Sec. of the Am. Inst. of Elec. Engrs. Historical review from the year 1880, when the American Electric Co. was formed, to 1888. 5000 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3476 F.

Resistances.

A New Form of Standard Resistance. Edward B. Rosa. Gives illustrated description of the new sealed standards, the apparatus employed in comparing coils, and the results. 5400 w. Bul Bureau of Stand—Feb., 1909. No. 3287 N.

Time Signals.

Electrical Time Service in Mauritius. E. D. Pearmain. Illustrates and describes the time signal system installed on this island of the Indian Ocean. 2000 w. Elec Rev, Lond—April 9, 1909. No. 3987 A.

INDUSTRIAL ECONOMY

Accidents.

A Year's Industrial Accidents in Pittsburg. Crystal Eastman. Condensed from the Pittsburg Survey in *Charities and the Commons*. Information concerning causes. 3500 w. Am Mach—Vol. 32. No. 13. No. 3655.

Accounting.

Some Recent Changes in Government Accounting. H. Parker Willis. Gives representative examples of each of the important classes of changes introduced during Mr. Roosevelt's term of office, as illustrative of the new point of view adopted. 8000 w. Jour of Acc—April, 1909. No. 4337 C.

The Machine Hour. F. E. Webner. The first of a series giving details of accounting plans as applied in the works of the Marion Steam Shovel Co. The present number deals with the antecedents and development of the machine hour idea. 3000 w. Ind Engng—April, 1909. Serial. 1st part. No. 4076 C.

Apprenticeship.

Industrial Training Through Apprentice Systems. E. P. Bullard. Read before the Nat. Met. Trds. Assn. Discusses the value of apprentice systems in raising the standard of industrial intelligence and related subjects. 2500 w. Ir Age—April 22, 1909. No. 4098.

Argentina.

Modern Argentina and its Commercial Relations with Belgium (L'Argentine moderne et ses Relations commerciales avec la Belgique). C. Lambotte. A review of agriculture, industrial and commercial progress. 4500 w. Rev de Métal—March, 1909. No. 4213 E + F.

Cost Systems.

The Principle of the Time Ticket. L. S. Randolph. Discussion of methods of obtaining labor costs of pieces and operations. 2000 w. Engineering Magazine—May, 1909. No. 4342 B.

Depreciation.

The Question of Depreciation in Manufacturing (Die Abschreibungsfrage in Industriebetrieben). A discussion of the fundamental principles in accounting for depreciation. Ills. 3500 w. Serial. 2 parts. Zeitschr f Werkzeug—March 15 and 25, 1909. No. 4285 each D.

Education.

Fundamental Principles of Industrial Education. Herman Schneider. Considers the problem, the field covered, the end to be attained and the general solution. 4000 w. Pro Am Inst of Elec Engrs—April, 1909. No. 3960 F.

The Defects of English Technical Education and the Remedy. Dr. Robert Pohl. Read before an Assn. of Teachers in Huddersfield. 4000 w. Nature—April 15, 1909. No. 4185 A.

Mining Education in the British Empire. Considers the education of working miners, of mine captains and managers, and of mining engineers, giving general conclusions. 5500 w. Min Jour—April 3, 1909. No. 3903 A.

Physical Chemistry and Electro-chemistry at the College of the City of New York. Leo Frank Guttmann. Illustrated description of the laboratories and their equipment. 1500 w. Elec-Chem & Met Ind—April, 1909. No. 3663 C.

The Scientific Education of Naval Architects. Prof. J. J. Welch. Reviews what has been done to insure the proper training of the British naval architect, especially considering the Admiralty systems. 9500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—April, 1909. No. 4372 N.

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Employers' Liability.

Employers' Liability for Accidents. Epaphroditus Peck. Extracts from an address before the Nat. Met. Trds. Assn. Discusses possible changes in the existing law. 2000 w. Ir Age—April 22, 1909. No. 4099.

Engineers.

The Engineer and the Engineer's Society. G. E. Flanagan. Address of retiring chairman, reviewing briefly what engineers have done and are doing. 3000 w. Pro Engrs' Soc of W Penn—March, 1909. No. 3816 D.

Management.

Effective Organization in the Assembling Department. Alfred Spangenberg. Outlines a system recommended. 2500 w. Am Mach—Vol. 32. No. 13. No. 3652.

Natural Resources.

The "Conservation" Meeting of the National Engineering Societies. A report of the March 24th meeting of the four societies to consider questions in connection with the conservation of the natural resources. Condensed papers. 9000 w. Eng News—April 1, 1909. No. 3762.

The American Institute of Mining Engineers and the Conservation of Natural Resources. John Birkinbine. Discusses this subject, giving instances of progress already made and the aid given by the Institute discussions in promoting conservation. 2500 w. Bul Am Inst of Min Engrs—April, 1909. No. 4087 F.

Annual Address of the President. Hon. J. H. Richards. A discussion of natural resources and the waste in mining, indicating the work of the American Mining Congress. 4500 w. Pro Am Min Cong—1908. No. 4117 N.

Conservation of Mineral Resources. J. B. Zerbe. Remarks on the pressing need of attention to this subject, especially considering coal. 1200 w. Pro Am Min Cong—1908. No. 4133 N.

The Conservation of the Resources of Minnesota. F. H. Bass. A discussion of some of the problems that must be solved by engineers in this connection. 3500 w. Minn Engr—March, 1909. No. 4062 C.

See also Conservation, under MINING AND METALLURGY, COAL AND COKE.

Patents.

The New British Patent Laws in Operation. A review of the practical results of the recent enactment. 2000 w. Cassier's Mag—April, 1909. No. 3638 B.

Profit-Sharing.

Profit Sharing. Papers by R. T. Crane and by N. O. Nelson, read at N. Y. meeting of the Nat. Met. Trds. Assn. 3500 w. Ir Age—April 22, 1909. No. 4100.

Tariff.

The Benefits of Protective Duties. Abstract of address by Col. Albert Clarke before the Phila. Found. Assn. Discusses the necessity of continued protection to American manufacturers. 2000 w. Ir Age—April 15, 1909. No. 3935.

The Payne Tariff Bill Passes the House. Gives the changes from the original draft. 3500 w. Ir Age—April 15, 1909. No. 3937.

The Senate Substitute Tariff Bill. Official text of the metal schedule of the Senate Finance Committee bill, reported to the Senate April 12. 8000 w. Ir Age—April 15, 1909. No. 3936.

A New Tariff for the Philippines. Gives the schedules covering metals and manufactures thereof and instruments, apparatus, machinery, vehicles, boats, etc. 3500 w. Ir Age—April 22, 1909. No. 4102.

Technical Journalism.

Technical Journalism. Ray Morris. An address before the engineering students of the University of Michigan, explaining the growing importance of technical literatures and the opportunities for engineers. 6500 w. R R Age Gaz—April 30, 1909. No. 4367.

Wage Systems.

Wage Systems. Robert Goldmann. From a paper presented before the Nat. Met. Trds. Assn. Brief review of the various systems and the objections to them. 2500 w. Ir Age—April 29, 1909. No. 4328.

MARINE AND NAVAL ENGINEERING

Admiral Melville.

George Wallace Melville. Walter M. McFarland. A tribute to his services to engineering and engineers. 1000 w. Engineering Magazine—May, 1909. No. 4345 B.

Battleships.

Types of Warships Omitted in Recent Programmes of Naval Construction. Lord Brassey. Read before the Inst. of Naval Archts. A brief discussion of the construction of battleships. 1500 w. Engng—April 2, 1909. No. 3906 A.

Fire Control Towers for Battleships. Charles B. Brewer. Illustrated description of fire control towers to be fitted to battleships of the United States Navy. 1000 w. Am Mach—Vol. 32. No. 16. No. 4106.

Cruisers.

The French Armoured Cruiser. Ernest Renan. J. G. Peltier. Illustrated description with report of trials. 1500 w. Int Marine Engng—April, 1909. No. 3686 C.

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Destroyers.

The Evolution of Speed in Torpedo Boat Destroyers. Fred A. Talbot. An illustrated review of development as shown in the Thornycroft vessels. 2500 w. Marine Rev—April, 1909. No. 3926.

The Torpedo-Boat Destroyer "Mohawk." E. Ommelange. Illustrated description of this turbine-driven destroyer of the British Navy. 1500 w. Int Marine Engng—April, 1909. No. 3684 C.

Dredges.

The Dredger Leviathan. Drawings and particulars of the largest dredger in the world. 2200 w. Engr, Lond—April 2, 1909. No. 3913 A.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

The Electrical Equipment of Liners and Battleships. A. P. Chalkley. Abstract of paper read before the Newcastle Sec. of the Inst. of Elec. Engrs. Discusses the reasons for the adoption of low-pressures for distribution on ships and describes typical arrangements of switchboards. Ills. 2500 w. Elect'n, Lond—March 25, 1909. No. 3779 A.

Ferry Boats.

Unique Rhine River Electric Ferry Boat. Illustrated description. 800 w. Marine Rev—April, 1909. No. 3927.

Ferry Boats for Kiel Harbor. Illustrated detailed description. 800 w. Int Marine Engng—April, 1909. No. 3685 C.

Danish State Railway Ferries. Harold M. Olsen. An outline of the construction and the services performed by this type of vessel. Ills. 4000 w. Inst of Engrs & Shipbldrs in Scotland—March 23, 1909. No. 3806 N.

The Car Ferries of the Danish Government. Axel Holm. Information in regard to the government ferry fleet, illustrating and describing some of the ferries. 2500 w. Int Marine Engng—April, 1909. No. 3681 C.

Gasoline Engines.

See Life Boats, under MARINE AND NAVAL ENGINEERING.

Hudson-Fulton.

The Coming Hudson-Fulton Celebration. Warren O. Rogers. An illustrated article describing the "Half-Moon" and "Clermont" replicas now being built to participate in the great naval parade. 1500 w. Power—April 27, 1909. No. 4310.

Internal-Combustion Engines.

The Application of Internal-Combustion Engines for Marine Propulsion. H. C. Anstey. Read before the Inst. of Naval Archts. Considers the advantages of fuel economy, weight and space. 3500 w. Mech Engr—April 2, 1909. No. 3902 A.

Internal Combustion Engines for Submarines. F. R. S. Bircham. Read before Inst. of Naval Archts. Discusses the requirements and the advantages and disadvantages of methods generally adopted, and considers the Diesel cycle engines. Ills. 3300 w. Mech Engr—April 9, 1909. No. 4028 A.

Marine Motors at Olympia. An illustrated review of exhibits. 3000 w. Engng—March 26, 1909. No. 3789 A.

See also Gasoline Engines, Motor Boats, and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Life Boats.

New Motor Life Boat for Sandy Hook Life Saving Station. Illustrated description of the 6-cylinder gasoline engine life boat. 1400 w. Naut Gaz—April 15, 1909. No. 3983.

Model Basins.

The Experimental Tank in Paris. Drawings and description of the plant and building containing it. 2000 w. Engr, Lond—April 2, 1909. No. 3910 A.

Report of the Experimental Tank Committee (1908). Read before the Inst. of Naval Archts. A report on the scheme for establishing an experimental tank at Bushy, in connection with the Nat. Phys. Laboratory. 4500 w. Engng—April 16, 1909. No. 4302 A.

Motor Boats.

The Proper Installation of a Marine Motor. A. E. Palmer. Describes the general method of procedure. Ills. 2500 w. Naut Gaz—April 29, 1909. No. 4346.

Small Motor Boats. F. R. S. Bircham. Abstract of paper before the Inst. of Auto Engrs. Deals with features desirable in the design anl installation of small marine internal combustion engines. 3000 w. Auto Jour—April 10, 1909. Serial. 1st part. No. 4024 A.

Oil Fuel.

Oil vs. Coal as a Marine Fuel. G. P. Blackiston. Presents the advantages of oil over coal. Ills. 800 w. Jour Am Soc of Naval Engrs—Feb., 1909. No. 4056 H.

Oil Fuel for Naval Use. H. C. Dinger. An illustrated description of the mechanical system of an oil installation, examining the advantages and disadvantages, and matters related to its economy and use. 7000 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4059 H.

Ore Carriers.

Distribution of Cargo in Ore Carriers on the Lakes. Address of Robert Logan before the masters and officers of the Pittsburg Steamship Co., with discussion. Diagrams. 3000 w. Marine Rev—April, 1909. No. 3929.

Propellers.

Propulsion of Vessels by Contrary Turning Screws. G. Rota. Read before the Inst. of Naval Archts. Shows the possible increase in efficiency by the use of contrary turning screws on a common

axis. Ills. 1800 w. Engng—April 9, 1909. No. 4035 A.

Screw Propeller Criticism and Notes on Screw Propeller Design Based on Actual Standardization Trial Results of U. S. Vessels. C. W. Dyson. 11500 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4060 H.

The Determination of the Thrust of Propellers. J. H. Heck. Read before the Inst. of Naval Archts. Sketches and description of a mechanical method for determining the thrust. 3500 w. Engng—April 9, 1909. No. 4034 A.

Comparative Tests on Screw Propellers. H. Lorenz. Trans. from *Zeit. des Ver. deutscher Ing.* Presents a new theory on the screw propeller, reporting tests and giving tables of experimental results. 2500 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4054 H.

Review of 1908.

Shipbuilding in 1908 (Der Schiffbau im Jahre 1908). F. Meyer and H. Dörwaldt. An exhaustive statistical review of shipbuilding operations all over the world. Serial. 1st part. 4500 w. Schiffbau—March 24, 1909. No. 4269 D.

Shipbuilding.

Standardization. Archibald Denny. Read before the Inst. of Naval Archts. Report of work done by the Engineering Standards Committee on sections and tests for materials used in the construction of ships and their machinery. 7000 w. Engng—April 2, 1909. No. 3909 A.

A System of Control for a Shipyard. W. J. Wilson. An explanation of a system, followed by discussion. Plates. 2000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1909. No. 3953 N.

See also Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Ship Design.

A Note on Ship Geometry. Sir George Greenhill. Read before the Inst. of Naval Archts. Discusses geometrically the alteration in trim and draught due to loading and unloading, coaling and burning the coal, due to the movement of weight on board, and the change due to passage from fresh to salt water, or the reverse. 1500 w. Engng—April 16, 1909. No. 4303 A.

Keels of Minimum Resistance (Note intorno alle Carene di Minima resistenza). Luigi Faucher. Discusses their form and design. Ills. 6500 w. Riv Marit—March, 1909. No. 4238 E + F.

German and English Merchant Vessels (Deutscher und englischer Handelsschiffbau). Carl Kielhorn. A comparison of German and English practice in ship design. Ills. Serial. 1st part. 4400 w. Schiffbau—March 10, 1909. No. 4268 D.

Ship Resistance.

On the Resistance of Thin Plates and Models in a Current of Water. T. E. Stanton. Read before the Inst. of Nav. Archts. Gives results of experiments, describing apparatus used. Ills. 3000 w. Engng—April 16, 1909. No. 4300 A.

Ship Specifications.

Ships' Specifications. J. R. Jack. Discusses briefly the technical qualities of a vessel and the requirements of a specification. 2500 w. Inst of Engrs & Shipbldrs in Scotland—March 23, 1909. No. 3805 N.

Ship Stability.

Stability and Comfort. Arthur R. Liddell. Discusses matters relating to stability of vessels. 2000 w. Engr, Lond—April 16, 1909. No. 4305 A.

Ship Vibration.

The Vibration of Ships. J. B. Henderson. Read before the Inst. of Naval Archts. Considers the elasticity of ships as deduced from experiments on the vibration of dynamical models. 4000 w. Engng—April 2, 1909. No. 3907 A.

Steamboats.

The "Robert Fulton." A Record in River Steamboat Construction. Illustrated description of this vessel which was launched in two months and ten days after the keel was laid. 1500 w. Sci Am Sup—April 10, 1909. No. 3840.

Steam Engines.

The Reciprocating Engine in Marine Practice and Its Probable Future. D. Gibson. Reviews the types of marine reciprocating engines now in use, and notes the considerations that determine the adoption of each type. Ills. 5000 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4057 H.

The Turbine and Reciprocating Engine for Naval Purposes. W. G. Diman. Examines the claims of the turbine and concludes that it has not yet shown enough advantage to warrant its taking the place of the reciprocating engine. 3000 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4055 H.

Se also Engine Lubrication, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

The Turbine Steamer "Ben-My-Chree." C. J. Blackburn. Read before the Inst. of Naval Archts. An account of practical experience with the Parsons marine steam turbine. Ills. 3000 w. Engng—April 9, 1909. No. 4036 A.

Steel Passenger Steamer. H. B. Kennedy. Illustrated description of a vessel for fast daylight service on Puget Sound. 2000 w. Marine Rev—April, 1909. No. 3928.

See also Ore Carriers, under MARINE AND NAVAL ENGINEERING.

Steam Turbines.

The Turbines of the Battleship "North Dakota." Illustrated description of the

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Curtis turbines installed on this ship of the "Dreadnought" type. 1000 w. Sci Am—April 17, 1909. No. 3946.

Turbines or Motors in Ships. Trans. from *Nauticus*. Compares the advantages and disadvantages of steam turbines and internal combustion engines. 13500 w. Jour Roy U S Inst—March, 1909. No. 3802 N.

Marine Turbines (Les Turbines marines). A general article on their construction, installation and operation. Ills. 3000 w. Tech Mod—March, 1909. No. 4230 D.

See also Destroyers, Steam Engines, and Steamships, under MARINE AND NAVAL ENGINEERING.

Submarines.

Submarine Navigation. Lindell T. Bates. A brief review of the development of the submarine vessel. Ills. 1500 w. Yale Sci M—April, 1909. No. 4373 C.

See also Internal-Combustion Engines, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

New Type of Sub-Surface Torpedo Boat. Illustration with description of a 25-knot boat, having the motors and torpedoes in a pear-shaped, submerged hull. 1000 w. Sci Am—April 10, 1909. No. 3838.

Torpedoes.

The Automobile Torpedo in Coast Defense. Richmond P. Davis. Brief review of development, discussing its usefulness, the launching, sub-marine boats, etc. Ills. 2500 w. Jour U S Art—March-April, 1909. No. 3801 D.

The Testing of Automobile Torpedoes (Batterie des Maures, Ilot artificiel de Lancement pour Essais de Torpilles automobiles). M. Michel-Schmidt. A detailed description of a launching station erected in Léoube bay, and the methods of testing. Ills. 14000 w. Mem Soc Ing Civ de France—Jan., 1909. No. 4203 G.

Wrecking Vessel.

Submarine Wrecking Vessel. Illustrated description of a new type built for the recovery of certain sunken treasure. 1000 w. Sci Am—May 1, 1909. No. 4330.

MECHANICAL ENGINEERING

AUTOMOBILES.

Adams.

A Good Car for the Moderate Man. Illustrated detailed description of the 14-16 h. p. Adams, a British built car. 2500 w. Auto Jour—March 27, 1909. No. 3773 A.

Adler.

The 12 h. p. Adler. Illustrated description of a light 4-cylinder car. 1200 w. Autocar—April 3, 1909. No. 3891 A.

Carbureters.

What to Do When the Carbureter Won't Work. Morris A. Hall. An illustrated discussion of sources of troubles and the remedies. 3500 w. Automobile—April 22, 1909. No. 4144.

Commercial Vehicles.

International Commercial Vehicle Competition of the Austrian Automobile Club in 1908 (Internationale Lastwagenkonkurrenz des Oesterreichischen Automobilklubs im Jahre 1908). Johann Trnovsky. Describes the vehicles entered, the tests and the results. Ills. Serial. 1st part. 4400 w. Oest Wochenschr f d Oeffent Baudienst—March 6, 1909. No. 4282 D.

The "Stae" Electric Automobile (Carri elettrici "Stae"). Describes various types of heavy electric trucks built at Turin, Italy. Ills. Serial, 1st part. 2000 w. Elettricita—March 18, 1909. No. 4239 D.

Construction.

Manufacture of Automobile Bodies. Illustrated brief discussion of details. 800 w. Wood Craft—April, 1909. No. 3729.

Pointers from the Manufacture of Automobile bodies. Illustrated article describing details of manufacture. 1500 w. Wood Craft—April, 1909. No. 3730.

Daimler.

The Daimler Engine Test. An illustrated account of the first stage of the trial. 900 w. Autocar—March 27, 1909. No. 3774 A.

Official Results of the Daimler Engine Tests. A report of a very severe series of tests, successfully endured with virtually no wear. Ills. 1200 w. Auto Jour—April 17, 1909. No. 4189 A.

Electric.

The Electric Vehicle Motor. J. T. Deremer. Read before the Pacific Coast Elec. Veh. Assn. Considers the motor, its controller, and their connection with each other. 2200 w. Elec Rev, N Y—April 17, 1909. No. 3997.

Abuses of Storage Batteries in Electric Vehicle Work. Walter L. Thompson. Considers the principal forms of abuse. 2000 w. Elec Rev, N Y—April 10, 1909. No. 3866.

See also Commercial Vehicles, and Garages, under AUTOMOBILES.

Fuels.

Automobile Gasoline and Other Available Fuel. Thomas J. Fay. Considers the amount of gasoline for a given case, radius of travel, economy, etc., in the present number. Ills. 3500 w.. Automobile—April 15, 1909. Serial. 1st part. No. 3969.

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Automobile Gasolene Involves Complex Problems. Thomas J. Fay. Discusses automobile fuel, the composite character of the gasolene used, some peculiarities, etc. Ills. 2500 w. Automobile—April 8, 1909. No. 3826.

Doping Petrol and How to Detect It. Horatio Ballantyne. Abstract of a paper entitled "Some Chemical Notes on Petrol," read before the Inst. of Auto. Engrs. Reviews attempts to improve petrol as a fuel for internal combustion motors. 2400 w. Auto Jour—April 3, 1909. No. 3890 A.

Garages.

The Electric Garage. S. P. Read. Read before the Pacific Coast Elec. Vehicle Assn. Discusses the necessity of an electric garage where electric vehicles are used, the requirements, arrangements, costs, etc. 1500 w. Elec Rev, N Y—April 3, 1909. No. 3748.

Gears.

Which is Better: Three or Four Speeds? Louis Lacoin. Gives the changes on the chassis needed for the fourth speed, and discusses its advantages in saving fuel and time. Ills. 2500 w. Automobile—April 15, 1909. No. 3970.

The Janney Hydraulic Gear for Autocars. Described from the patent specification by Eric W. Walford. Ills. 700 w. Autocar—April 3, 1909. No. 3892 A.

Inspection.

Preparing a Car Systematically for the Road. D. R. Hobart. Suggestions in regard to the attention a car should receive before starting. 800 w. Automobile—April 29, 1909. No. 4349.

Motor Cooling.

Concerning Air-Cooling as Opposed to Water-Cooling. Arthur Holmes. A criticism of statements in an earlier article by Morris A. Hall. 1800 w. Automobile—April 22, 1909. No. 4146.

Cooling Automobile and Aeronautical Motors (Die Kuhlung der Automobil und Flugmotoren). F. Ernstes. Illustrated description of a large number of arrangements for air and water cooling. Serial. 1st part. 6000 w. Zeitschr d Mit Motorwagen Ver—March 31, 1909. No. 4277 D.

Motor Starting.

Self Starting Devices. Illustrates and briefly describes the important features and methods of operation of the principal self-starting devices now in use. 2200 w. Automobile—April 1, 1909. No. 3679.

Motor Testing.

See Daimler, under AUTOMOBILES.

Pearson-Cox.

A New British-Built Steam Car. Illustrated detailed description of the 12 h. p. low-priced car of Pearson and Cox. 3000 w. Auto Jour—April 3, 1909. No. 3889 A.

Tractors.

A Novel Steam Tractor for Hauling Logs Over Snow. Illustrated description of a machine of the "caterpillar" type, propelled by steam. 600 w. Sci Am Sup—May 1, 1909. No. 4331.

Wheels.

The "Panflex" Spring Wheel for Motor-Cars. Illustrated description of a new type, and its operation. 1000 w. Engng—April 16, 1909. No. 4301 A.

COMBUSTION MOTORS.

Aeronautical.

See Motor Cooling, under AUTOMOBILES; and Gasoline Engines, under COMBUSTION MOTORS.

Constant-Pressure.

A Constant-Pressure Internal-Combustion Engine. H. B. Stilz. Reviews the theory of these engines and gives an illustrated description of a design by the writer. Also editorial. 6000 w. Eng News—April 22, 1909. No. 4159.

Fuels.

The Cost of Denatured Alcohol (Le Prix de Revient de l'Alcohol dénaturé). R. P. Duchemin. A discussion of the cost of the denaturing process using methylene. 2400 w. Tech Mod—March, 1909. No. 4232 D.

Gas Engines.

A Method of Improving the Efficiency of Gas Engines. Thomas E. Butterfield. An account of experiments made to show the effect of dilution of charge with inert gas. 3000 w. Jour Am Soc of Mech Engrs—April, 1909. No. 3965 F.

Compression in Gas Engines (Remarques sur la Compression des Moteurs à Gaz). E. Jouguet. A review of the theories on which the use of high compression is based. Ills. 4500 w. Rev de Mécan—March, 1909. No. 4221 E + F.

Progress in Gas Engine Construction (Les Progrès de la Construction des Moteurs à Gaz). R. E. Mathot. A review of results, objections, certain principles and details of construction, and possible improvements. Ills. 11200 w. Mem Soc Ing Civ de France—Jan., 1909. No. 4201 G.

Formulas and Tables for Horse-Power of Gasoline Engines. Morris A. Hall. With explanatory notes. 600 w. Mach, N Y—April, 1909. No. 3648 C.

Aeronautical Motors (Motoren für Luftfahrzeuge). E. Rumpler. A discussion of the requirements and descriptions of a large number of types. Ills. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—March 20, 1909. No. 4293 D.

Gas-Power Plants.

Producer Gas Power Observations. T. S. Daniel. Discusses design, operation, and cost of gas producer plant. 2500 w. Minn Engr—March, 1909. No. 4067 C.

A Small Producer-Gas Power Plant in a Watch Factory. Describes a successful plant in Jersey City, N. J. 2800 w. Eng Rec—April 17, 1909. No. 4012.

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See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gas Producers.

Producer Gas for Engines. J. Emerson Dowson. Considers the process of making producer gas and some of the chemical reactions involved. Ills. 2500 w. Nature—April 15, 1909. Serial. 1st part. No. 4184 A.

Suction Producer Plants Using Culm as Fuel (Sauggeneratorengasanlagen mit Kohlenlöschebetrieb). Herr Diedrich. Illustrates and describes the producers in two plants in Germany operating on culm, fine coal, coke dust, etc. 3000 w. Glasers Ann—March 1, 1909. No. 4275 D.

The Letombe Gas Producers (Les Gazogènes de M. Letombe). M. Brüll. Illustrated detailed description. 1500 w. Bul Soc d'Encour—March, 1909. No. 4217 G.

Oil Engines.

Combined Oil Engine and Dynamo. Brief illustrated description of small combined lighting sets. 500 w. Engr, Lond—April 2, 1909. No. 3912 A.

Producer Gas.

The Use of Producer Gas in Chemical and Metallurgical Industries. Dr. Oskar Nagel. Illustrated description of various applications. 800 w. Elec-Chem & Met Ind—April, 1909. No. 3661 C.

HEATING AND COOLING.

Car Barns.

Heating a Trolley Car Barn. J. Irving Brewer. Shows the application of principles recognized as good heating practice, to the design of the heating system for a trolley car barn suitable for inspecting cars and making light repairs. Plan. 2000 w. Eng News—April 29, 1909. No. 4359.

Cooling Towers.

Cooling Towers. Samuel K. Patteson. Illustrates and describes methods of conserving water for condensing purposes. 2500 w. Cassier's Mag—April, 1909. No. 3636 B.

Cooling Towers (Ueber Rückkühlwerke). E. Arnold. A discussion of cooling tower practice and design with results of tests on a number of towers. Ills. 4500 w. Stahl u Eisen—March 3, 1909. No. 4249 D.

Fans.

Experiments on the Efficiency of Ceiling Fan Blades. L. Murphy. Describes the investigations and gives the results. 1500 w. Elec Rev, Lond—April 2, 1909. No. 3895 A.

Heat Transmission.

Heat Transmission Coefficients (Beitrag zur Kenntnis des Wärmetransmissionskoeffizienten). Ludwig Dietz. Gives the results of a long series of tests. Ills. 3800 w. Gesundheits-Ing—March 20, 1909. No. 4278 D.

Hot-Air Heating.

A Mechanical Furnace Heating System. Plans and description of the heating and ventilating plant for the High School building at Barnesville, Ohio. 4500 w. Met Work—April 10, 1909. No. 3844.

Refrigeration.

The Renaissance of the Absorption Machine. Jos. H. Hart. Presents some of its advantages in application and operation. 3500 w. Engineering Magazine—May, 1909. No. 4343 B.

Refrigerating Machine Operation. Especially discusses the details of the improved absorption machines. 2500 w. Prac Engr—April 9, 1909. No. 3993 A.

The Use of Indicators in Refrigeration. Samuel K. Patteson. Discusses the limitations of the diagram in this work, its meaning in compression, and its value, especially in valve setting. 3000 w. Power—April 20, 1909. No. 4050.

The First International Congress of the Cold (Le premier Congrès international du Froid). L. Marchis. A review of the composition of the congress. 8500 w. Rev Gen des Sci—March 15, 1909. No. 4223 D.

Steam Heating.

Heating and Ventilating a Banking Building. Charles L. Hubbard. Drawings and descriptions of practically separate systems. 2000 w. Met Work—April 17, 1909. No. 3984.

Ventilation.

Principles of Heating and Ventilating a Modern Building. H. W. Woodward. General discussion, with illustrated description of the heating and ventilating system of the Cuyahoga Co. Court House, Cleveland, O., which is a combination of direct radiation and mechanical ventilation. 5000 w. Ind Engng—April, 1909. No. 4074 C.

See also Steam Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Hydraulic Tables.

Hydraulic Tables. Joseph H. Harper. An outline of work attempted by the writer. 1500 w. Jour Assn of Engng Socs—Feb., 1909. No. 3962 C.

Pumping Plants.

The Garden City Pumping Plant. F. W. Hanna. Illustrated description of a power plant in connection with an irrigation project in Kansas. 1200 w. Eng Rec—April 24, 1909. No. 4168.

Pumps.

See Water Wheels, under HYDRAULIC MACHINERY.

Turbine Plants.

The Design of Intakes for Hydro-Electric Plants. Jean. Bart. Balcomb. Gives method employed by the writer, describing an actual case. 1200 w. Eng News—April 8, 1909. No. 3854.

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Means of Preventing Danger from High Water in Water-Power Plants (Technische Massnahmen, um den Rückstau des Hochwassers für Wasserkraftanlagen unschädlich zu machen). Herr Danckwerts. A discussion of flood-water regulation. Ills. Serial. 1st part. 2500 w. Die Turbine—March 20, 1909. No. 4271 D.

Water Wheels.

Current-Pumps on the Clutha River. Frank Reed. Drawings, photograph and description of Payne's patent current-wheel pumping plant. 1200 w. N Z Mines Rec—Feb. 16, 1909. No. 3884 B.

Wave Motors.

The Status of the Wave Motor. James T. Barkelew. Considers the different forms and their effectiveness, cost of installation and upkeep. 3000 w. Power—April 13, 1909. No. 3920.

MACHINE ELEMENTS AND DESIGN.

Bolts.

The Strength of Bolts. Brief discussion of the stresses in bolts under various conditions. 900 w. Mech Wld—April 9, 1909. No. 3990 A.

Brakes.

Dynamic Braking. Henry D. James. Considers applications, methods of control, and cost. Ills. 2500 w. Elec Jour—April, 1909. No. 3952.

Electrically Operated Brakes for Industrial Purposes. H. A. Steen's paper is discussed. 4000 w. Pro Engrs' Soc of W Penn—March, 1909. No. 3815 D.

Cams.

See Stamp Mills, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Chains.

A Weldless Chain Shackle. Illustrated description of the Kenter shackle, explaining its advantages. 1200 w. Engr, Lond—April 9, 1909. No. 4039 A.

Crane Hooks.

Crane Hooks. H. J. Mastenbrook. Gives formulae and tables for calculating dimensions, with explanation. 600 w. Mach, N Y—April, 1909. No. 3642 C.

Springs.

A Study of Cylindrical Spiral Springs (Etude sur le Ressort à Boudin). M. Astier. Mathematical. Ills. 3000 w. Rev de Mécan—March, 1909. No. 4222 E + F.

Strength of Materials.

Investigations of Transverse Elasticity and Shearing Strength (Versuche über die Schubelastizität und -festigkeit). M. Grübler. A report of elaborate tests. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—March 20, 1909. No. 4294 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing High-Speed Steel. O. M. Becker. Detailed discussion of methods. 1500 w. Am Mach—Vol. 32. No. 16. No. 4107.

Boiler Making.

A Device for Setting Boiler Tubes (Un Appareil à sertir les Tubes de Chaudières). E. Sauvage. Describes a method of setting tubes devised by M. Gallon. Ills. 3200 w. Bul Soc d'Encour—Feb., 1909. No. 4215 G.

Brass Founding.

The Use of the Liver of Sulphur Dip, and Its Application in the Production of Various Finishes on Metals. Illustrates and describes its action and various finishes produced. 2000 w. Brass Wld—April, 1909. No. 4109.

Castings.

The Production of Sound Castings. Robert Buchanan. A lecture on the materials and methods necessary for the production of perfect castings. 10500 w. Jour W of Scotland Ir & Steel Inst—Jan., 1909. No. 4318 N.

Interesting Tests of Steel Castings. An illustrated account of a ballistic test of a cast steel cylinder to detect internal strains, and of hydrostatic tests of high pressure values. 1200 w. Ir Trd Rev—April 29, 1909. No. 4350.

Chain Making.

Chains Without Transverse Welds. Illustrated description of a new method for the manufacture of chains of every kind and size, invented by Alfred Marion, of Brussels. 1200 w. Engr, Lond—March 26, 1909. Serial. 1st part. No. 3792 A.

See also Forging, under MACHINE WORKS AND FOUNDRIES.

Cutting Tools.

Tests of Lathe Tools for Finishing Cuts. W. A. Knight. Gives diagrams obtained by means of a special indicator, with description of tests. Ills. 3000 w. Am Mach—Vol. 32. No. 14. No. 3832.

Drilling.

High Speed Drilling Tests. George E. Hallenbeck. Gives results of tests made with high speed drills on the Baker high-speed drilling machine. Ills. 1000 w. Ir Age—April 29, 1909. No. 4326.

Drilling Machines.

Two Machine Tools. Illustrated detailed descriptions of new designs for a duplex horizontal boring and turning mill, and a duplex four-spindle drilling machine. 1200 w. Engr, Lond—April 16, 1909. No. 4306 A.

Enamelling.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

File Testing.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Forging.

The Making of Large Drop Forgings. E. F. Lake. Describes the machines, dies, and steel used, and the operations in forging a 400-lb. crank shaft. Ills. 1500 w. Am Mach—Vol. 32. No. 15. No. 3940.

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The Forging of Hooks and Chains. James Cran. Information concerning the diameter and length of material to use for different capacities, methods, etc. Ills. 2000 w. Mach, N Y—April, 1909. No. 3646 C.

Foundries.

A Modern Pacific Coast Foundry. H. Cole Estep. Illustrated description of a new casting plant in Portland, Oregon. 2000 w. Foundry—April, 1909. No. 3732.

Foundry Equipment.

Some Considerations on the Use of Electricity in Foundries. J. W. Warr. How electricity can be applied to foundry work, with suggestions as to the best methods to insure efficient working. 3500 w. Elec Rev, Lond—April 16, 1909. No. 4191 A.

See also Sand Blast, under MACHINE WORKS AND FOUNDRIES.

Furnaces.

Furnaces for and Methods of Hardening. C. U. Scott. Illustrates a hardening room and its equipment, describing methods of hardening, annealing, tempering, etc. 3500 w. Am Mach—Vol. 32. No. 17. No. 4353.

A New Electrical Hardening Furnace. E. Sabersky and E. Adler. Abstract of a paper before the Faraday Soc. Explains the working principle. 3500 w. Elec Engr, Lond—April 2, 1909. No. 3894 A.

Muffle Furnaces for Use in the Enamelling and Other Industries (Muffelöfen für Emaillierwerke und andere industrielle Zwecke). Ernst A. Schott. Illustrated description of various types. 2500 w. Serial, 2 parts. Giesserei-Zeit—March 15, and April 1, 1909. No. 4257 each D.

Gear Cutting.

Cutting Helical Gears on the Brown and Sharpe Automatic Screw Machine. Illustrated detailed description. 2000 w. Mach, N Y—April, 1909. No. 3649 C.

The Making of Gear Shaper Cutters. Considers the generation of curved surfaces as applied to the making of the formed cutters for the Fellows gear shaper. Ills. 2500 w. Am Mach—Vol. 32. No. 15. No. 3939.

Grinding Wheels.

The Making of Modern Grinding Wheels. Gives an illustrated outline of the process by which carborundum is made, and its manufacture into grinding wheels. 2000 w. Am Mach—Vol. 32. No. 13. No. 3651.

Gun Making.

Making Big Guns at Bethlehem Steel Co. E. F. Lake. Illustrates and describes interesting features of work on guns for the U. S. Government. 1500 w. Am Mach—Vol. 32. No. 14. No. 3831.

Lathes.

Special French Lathes for Bar Work. Joseph G. Horner. Illustrated detailed description of one of these lathes and its operation. 1200 w. Am Mach—Vol. 32. No. 17. No. 4354.

Machine Tools.

Elements of Machine Manufacture. Fred J. Miller. Lecture at Columbia Univ., N. Y. Discusses the design, construction, strength, cost, etc., of machine tools. Diagrams. 5000 w. Mach, N Y—April, 1909. No. 3647 C.

The Factors Influencing the Efficiency of Metal-Working Machine Tools. M. H. Landis. Brief consideration of the many factors affecting the efficiency. 1000 w. Sib Jour of Engng—March, 1909. No. 4053 C.

See also Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Magnetic Separators.

Magnetic Separators for Various Uses. S. R. Stone. Illustrates and describes methods of separating iron products from sand, clay, coke, coal, scrap, junk, etc., and the saving effected. 2500 w. Am Mach—Vol. 32. No. 17. No. 4352.

Milling Cutters.

The Design of Milling Cutters. C. J. Morrison. Outlines practice said to produce efficient cutters at low cost. Ills. 1500 w. Am Engr & R R Jour—April, 1909. No. 3799 C.

Tools for Milling Turbine Buckets. William E. Snow. Illustrates and describes the rotary milling attachment, special cutters, and a cutter-driving device. 1000 w. Am Mach—Vol. 32. No. 14. No. 3835.

Molding.

Plaster of Paris Molds and the Method of Casting Metals in Them. An illustrated article discussing materials and methods, especially the methods used by the Gorham Mfg. Co. 5000 w. Brass Wld—April, 1909. No. 4108.

Making Mold Joints and Partings. James F. Buchanan. Suggestions for molders. Ills. 2000 w. Foundry—April, 1909. No. 3735.

Hinged Match Plate for Stone Work. Illustrated description of a new process for molding stone plates which permits of returning the pattern to the mold. 2500 w. Foundry. April, 1909. No. 3731.

Propeller Molding. Useful hints, with illustrations. 1700 w. Sci Am Sup—April 10, 1909. No. 3842.

Castings for Printing Presses. Illustrates and describes methods of molding large gray iron cylinders. 2500 w. Foundry—April, 1909. No. 3734.

Molding Sand.

Automatic Sand-Preparing Apparatus. Illustrated description of an apparatus for the automatic preparation of molding sand. 1000 w. Engng—April 2, 1909. No. 3908 A.

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Pattern Plates.

Reversible Pattern Plate Process. George Muntz. Illustrates and describes a new and simple method of producing these plates for foundry use. 1800 w. Foundry—April, 1909. No. 3733.

Sand Blast.

The Sand Blast in Foundry Cleaning (Das Sandstrahlgebläse in der Gussputzerei). W. Caspari. Describes various systems, the uses of the sand blast, and apparatus for a variety of purposes. Ills. Serial, 1st part. 2800 w. Stahl u Eisen—March 17, 1909. No. 4251 D.

Scraping.

Labor-Saving Devices for Scraping Operations. Alfred Spangenberg. Illustrates and describes a number of devices for pulling, holding, etc. 2000 w. Mach, N Y—April, 1909. No. 3644 C.

Sheet Metal Work.

Punch and Die for Corrugating Thin Copper Sheets. A. L. Monrad. Illustrated description of punch and die designed for forming copper corrugations from copper sheets. 2000 w. Mach, N Y—April, 1909. No. 3645 C.

Shop Appliances.

Tools for the Workshop. I. G. Bayley. The present number describes a carpenter's clamp, and a steam box. Ills. 700 w. Sci Am—April 24, 1909. Serial, 1st part. No. 4112.

Some Interesting Shop Tools and Methods. Describes interesting applications of concrete, tools and fixtures in use in Greenfield, Mass. Ills. 1600 w. Am Mach—Vol. 32, No. 14. No. 3833.

Some Test Fixtures and a Milling Attachment. Illustrates and describes tools used in finishing and testing the parts of the Burroughs adding machine. 1200 w. Am Mach—Vol. 32, No. 15. No. 3941.

Special Tools and Devices for Automobile Factories. Ethan Viall. Illustrates and describes devices used at the factory of the E. R. Thomas Motor Co., Buffalo, N. Y. 800 w. Mach, N Y—April, 1909. No. 3641 C.

Shop Hygiene.

Improvements in the Hygienic Arrangement and Operation of Workshops (Perfectionnements hygiéniques réalisés dans l'Installation et la Fonctionnement des Ateliers industriels). A review of the report of the French Minister of Industry, covering heating, ventilation, lighting, etc. 4500 w. Rev d'Econ Indus—Mar. 16, 1909. No. 4200 D.

Shop Practice.

Machine Shop Practice. The present number describes cylindrical grinding, illustrating machines. 2000 w. Mach, N Y—April, 1909. Serial, 1st part. No. 3650 C.

Machining Petrol Motor Cylinders. Sydney Laurence. Illustrated detailed description of tools and methods used. 1200 w. Mech Wld—April 9, 1909. Serial, 1st part. No. 3991 A.

Building the Pierce Great Arrow Car. Illustrated description of methods, tools, etc., used in a plant at Buffalo, N. Y. 2500 w. Am Mach—Vol. 32, No. 15. No. 3938.

Record Breaking Engine Building. An illustrated account of the building of a 36 x 72-inch heavy-duty Corliss engine in 30 days. 1200 w. Am Mach—Vol. 32, No. 16. No. 4103.

Building the Rotors of High-Speed Hydraulic Turbines (Construction en Série des Roues mobiles des Turbines mixtes à grande Vitesse). Jacques Lafitte. Discusses the methods of molding and attaching the canes. Ills. 2000 w. Génie Civil—March 6, 1909. No. 4234 D.

Shops.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Tempering.

The Tempering of High Speed Steel. O. M. Becker. Describes methods used, and gives temperature data. 2500 w. Am Mach—Vol. 32, No. 14. No. 3836.

Gaging Heats for Hardening Carbon Steel. James Cran. Brief discussion of effect of carbon content, use of magnetic needle, and related matters. 1500 w. Am Mach—Vol. 32, No. 14. No. 3834.

A Modern English Hardening Room. M. Thornton Murray. Illustrates and describes a typical modern room in a plant at Manchaster, England. 2500 w. Am Mach—Vol. 32, No. 13. No. 3653.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Tool Rooms.

Tool Rooms for Small Shops. F. C. Myers. Remarks and suggestions for a system of caring for tools. 1400 w. Mech Wld—April 9, 1909. No. 3989 A.

Welding.

Liquid Gas for Welding and Lighting. E. F. Lake. Illustrates and describes the manufacture and properties of the gas, and its uses for welding, lighting, brazing, etc. 2200 w. Am Mach—Vol. 32, No. 16. No. 4105.

Aluminum Casting Repairs. Henry Cave. Illustrated descriptions of the successful application of the oxy-acetylene blow-pipe. 1200 w. Ir Age—April 22, 1909. No. 4101.

Repair of Aluminum Castings by Oxy-Acetylene. Henry Cave. Illustrates and describes the successful welding of aluminum by this process. 1200 w. Automobile—April 22, 1909. No. 4145.

Autogenous Welding of Aluminum. M. U. Schoop. A report of experimental study and success. 2000 w. Elec-Chem & Met Ind—April, 1909. No. 3658 C.

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Autogenous Welding as a Means of Repairing Cylinders. Henry Cave. Illustrates and describes repairs made by the use of the oxy-acetylene flame. 1800 w. Mach, N Y—April, 1909. No. 3643 C.

Cylinders Repaired by Autogenous Welding. Henry Cave. Illustrates and describes the work as done with Davis-Bournonville apparatus. 1800 w. Ir Age—April 15, 1909. No. 3934.

Welding Plates by Machine and the Testing of Welded Joints (Das Schweissen von Blechen auf Schweisstrassen und die Prüfung der Schweissnähte). C. Diegel. Describes the process of water-gas welding, its advantages, and results. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—March 13, 1909. No. 4293 D.

See also Rail Bending, under STREET AND ELECTRIC RAILWAYS.

MATERIALS OF CONSTRUCTION.

Alloys.

"Ferro-Bronzes." Robert Grimshaw. Describes some new alloys and their composition. 1200 w. Sci Am Sup—April 24, 1909. No. 4115.

See also Solders, under MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Influence of Nickel and Carbon on Iron (Der Einfluss von Nickel und Kohlenstoff auf Eisen). G. Goldberg. A review of the results obtained and the conclusions reached by various investigators. Ills. 2600 w. Serial, 2 parts. Giesserei-Zeit—March 15, and April 1, 1909. No. 4255 each D.

The Properties of Nickel Steel (Zur Kenntnis der Festigkeitseigenschaften des Nickelstahles). Gives results of tests of the strength of nickel steels of various compositions and under various conditions. Ills. 1400 w. Stahl u Eisen—March 24, 1909. No. 4252 D.

Bronzes.

Japanese Bronzes (Japanische Bronzen). Paul Martell. A discussion of the composition and manufacture of these alloys. 2500 w. Giesserei-Zeit—March 1, 1909. No. 4254 D.

Copper.

Fatigue of Copper Pipes. James M. Allan. A report of experimental investigations. Plates. Discussion. 7500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1909. Serial, 1st part. No. 3954 N.

The Characteristics of Copper Under Various Conditions. George W. Handscomb. Abstract of paper read before the Inst. of Marine Engrs. Deals with the manipulation of this metal at the hands of the copper worker. 2500 w. Ir & Coal Trds Rev—March 26, 1909. Serial, 1st part. No. 3820 A.

Heat Insulation.

Heat Insulating Materials. A new method of determining their value, explained in an article by Wilhelm Nusselt, in the *Zeit. für die Gesamte Kalte Ind.* 2000 w. Ice & Cold Storage—April, 1900. Serial, 1st part. No. 3888 A.

Metallography.

The Behavior of Metals Under Stress. Prof. Chapman. Presidential address on the microstructure of metals, their fatigue and the scientific side of engineering practice. 3500 w. Aust Min Stand—Feb. 24, 1909. Serial, 1st part. No. 3880 B.

Transparency of Metals. J. Horton. Considers experimental study of the optical phenomena of thin metallic films. 1000 w. Cassier's Mag—April, 1909. No. 3640 B.

Metallography of Steel. O. F. Hudson. Read before the Birmingham Assn. of Mech. Engrs. Considers the effect of heat treatment on steel and the importance of microscopic testing. 3000 w. Mech Engr—April 9, 1909. No. 4031 A.

The Examination of Metals (Ueber Metallforschung). H. Winter. A review of the general principles of the microscopic examinations of metals, with examples of metallographic studies. Ills. 4800 w. Glückauf—March 27, 1909. No. 4266 D.

See also Alloys, under MINING AND METALLURGY, MISCELLANY.

Solders.

Solders and Fusible Alloys. S. K. Patteson. Their composition, action, utilization, etc., are discussed. 1800 w. Mech Wld—March 26, 1909. No. 3783 A.

Standardization.

See Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Steel.

The Elasticity and Fatigue of Wrought Iron and Steel. Henry S. Pritchard. Explains these terms as applied to metals, and the phenomena, giving results of experimental study of stresses, overstrain, etc. 5000 w. Ind Engng—April, 1909. No. 4075 C.

See also Metallography, under MATERIALS OF CONSTRUCTION.

Tool Steels.

High-Speed Steel. A report of tests made at Nash's Test House, Sheffield, England. 700 w. Engr, Lond—April 2, 1909. No. 3911 A.

The Testing of Files and Tool Steel. Edward G. Herbert. Read before the Manchester Assn. of Engrs. Shows the importance of file testing in workshop economy, and illustrates and describes a machine used in making the tests, giving results, efficiency, etc. 6000 w. Mech Engr—April 2, 1909. Serial, 1st part. No. 3901 A.

Wrought Iron.

See Steel, under MATERIALS OF CONSTRUCTION.

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MEASUREMENT.

Calorimeters.

An Automatic Calorimeter (Automatisches Kalorimeter). Herm. F. Lichte. Describes the principle and operation of the Junker continuous recording calorimeter. Ills. 1500 w. Giesserei-Zeit—March 15, 1909. No. 4256 D.

Ergometer.

The Inertia Ergometer of Joseph Doyen and the Resulting Dynamometrical Methods. A. Huberti and J. Doyen. Describes this instrument for measuring the work of the inertia forces, and its use. 5000 w. Bul Int Ry Cong—March, 1909. No. 3955 G.

Gages.

Limit Gages and Thread Micrometers. Discusses the need and use of limit gages in plain and threaded work and a micrometer for measuring the flats. Ills. 1500 w. Am Mach—Vol. 32, No. 13. No. 3654.

Micrometers.

See Gages, under MEASUREMENT.

Pyrometry.

Temperature Determination and Control for High-Speed Steel Treatment. O. M. Becker. First of two articles reviewing methods and instruments in practical use in industrial processes. Ills. 2500 w. Engineering Magazine—May, 1909. No. 4339 B.

Pyrometers for Measurement of High Temperature. Richard P. Brown. Illustrates and describes many types of instruments used industrially. 3500 w. Pro Engr Club of Phila—Oct., 1908. No. 4325 D.

Tachometers.

A New Revolution Recorder and Indicator. F. F. Uehling. Illustrated description of mechanisms designed by the writer. 1200 w. Stevens Ind—Jan., 1909. No. 3811 D.

Speed Measuring Instruments and Their Testing (Ueber Geschwindigkeitsmesser und deren Prüfung). A. Wagener. Describes an apparatus for testing speed-measuring instruments in the laboratory. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—March 27, 1909. No. 4296 D.

Water.

See Boiler Waters, under STEAM ENGINEERING.

POWER AND TRANSMISSION.

Air Compressors.

The Compressed Air Plant for the Rondout Siphon. Illustrated description of the power plant for work on this portion of the Catskill Aqueduct. 2000 w. Eng Rec—April 10, 1909. No. 3861.

Belt Driving.

Belting Compared with Chain Transmission. Harrington Emerson. Paper read before the Leather Belting Mfrs.' Assn. Some statements in regard to the service of chains and belts. 1200 w. Power—April 6, 1909. No. 3769.

Costs.

Notes on the Cost of Power. H. G. Stott. Compiled with the aim of showing the fundamental relations between the various items that make up the cost. 700 w. Diagrams. Pro Am Inst of Elec Engrs—April, 1909. No. 3959 F.

Reducing the Cost of Power in Works and Factories. Joseph A. Jeckell. Read before the Birmingham (Eng.) and District Elec. Club. Calls attention to wasteful methods of making and using power. 3000 w. Elec Engr, Lond—March 26, 1909. No. 3775 A.

Electric Driving.

Emergency Connections for Electric Motors. C. V. Hull. Describes departures from conventional methods, used in emergencies. 1200 w. Power—April 27, 1909. No. 4312.

Slow-Speed Drive of Single-Motor Web Presses. S. H. Sharpsteen. Discusses methods of control. Ills. 2500 w. Elec Rev., N Y—April 17, 1909. No. 3996.

Gas Power.

The Value of Gas Power. Charles E. Lucke. Brief discussion of the conditions that fix the best field for the gas power plant, giving information of cost, fixed charges, etc. 5500 w. Pro Soc of Ap Sci—Session 1908-1909. No. 4096 C.

Power Plants.

Power Plant of West Point Military Academy. Illustrated detailed description of the plant for lighting, heating and power purposes. 6000 w. Power—April 27, 1909. No. 4309.

Increasing the Efficiency of Factory Power Houses. R. A. Smart. Considers points affecting the general efficiency and economy of the plant. Ills. 7000 w. Elec Jour—April, 1909. No. 3950.

Combined Lighting and Heating Plants for Modern Commercial Buildings (Die kombinierte Beleuchtung und Heizung moderner Geschäftsgebäude). Carl Fred. Holmboe. Discusses their design and first and operating costs. Ills. 2000 w. Elektrotech u Maschinenbau—March 14, 1909. No. 4287 D.

Shafting.

Hanging Wires and Shafting in a Concrete Factory. Methods used in concrete factory buildings at Hoboken, N. J., as described by Morris W. Lee in *The Armour Engr.* 2500 w. Eng Rec—April 24, 1909. No. 4172.

STEAM ENGINEERING.

Boiler Design.

Bracing Dome Heads. James Smith. Illustrated descriptions of methods used. 1000 w. Power—April 6, 1909. No. 3767.

The Riveted Joints of Cylindrical Boil-

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ers. H. K. Spencer. Discusses only those joints commonly used in cylindrical boilers. Ills. 3500 w. Int Marine Engng—April, 1909. No. 3682 C.

Boiler Draft.

The Significance of Drafts in Steam-Boiler Practice. Walter T. Ray and Henry Kreisinger. An illustrated report of experimental investigations in regard to the passage of air through fuel beds and boilers. 12000 w. U S Geol Surv—Bul 367. No. 4116 N.

Boiler Furnaces.

Principles of Furnace Design for Smokeless Combustion. C. H. McClure. Read before the Am. Chem. Soc. Discusses the conditions required for smokeless combustion, and types that have proved both smokeless and efficient. 2500 w. Boiler Maker—May, 1909. No. 4182.

Tube Tiles Used to Form Furnace Roofs. A. Bement. Illustrates and describes the encircling of the lower row of tubes in a water-tube boiler with refractory firebrick tiles to increase efficiency and prevent smoke. 1200 w. Power—April 6, 1909. No. 3766.

See also Fuels, under STEAM ENGINEERING.

Boiler Inspection.

Harnessing Power in Greater New York. A. C. Rowsey. An explanation of the work of the Boiler Inspection Bureau, and its great responsibility. 5000 w. Power—April 20, 1909. No. 4046.

Boiler Waters.

Measuring Boiler Feed Water. W. R. Degenhardt. Illustrates and describes Harding's revolution counter. 900 w. Aust Min Stand—March 3, 1909. No. 3881 B.

Condensers.

The Theory of Steam Condensers. Thomas C. McBride. A statement of the fundamental laws governing the operation of condensers, the measurements to be taken, and the instruments employed. Discussion. 4500 w. Pro Engrs' Club of Phila—Oct., 1908. No. 4322 D.

Cooling Towers.

See same title, under HEATING AND COOLING.

Engine Bearings.

Hot Bearings; Some Causes and Remedies. H. S. Brown. Diagrams. 2000 w. Power—April 6, 1909. No. 3768.

Engine Design.

Steam Engine Design. The present article discusses general proportions, cylinder ratios, cut-off and expansions, temperature range and pressures. 1200 w. Prac Engr—March 26, 1909. Serial. 1st part. No. 3782 A.

Engine Lubrication.

Forced Lubrication. Henderson B. Gregory. An illustrated general description of the installation and operation as applied to large marine reciprocating engines. 1200 w. Jour Am Soc of Nav Engrs—Feb., 1909. No. 4058 H.

Engine Operation.

Analysis of Steam and Inertia Forces. F. W. Hollman. Graphical explanation of the inertia forces of a tandem-compound engine and their combination with the steam forces in each cylinder. 1200 w. Power—April 6, 1909. No. 3765.

Engines.

Compound Semi-Portable Engine and Superheater. Brief illustrated description of an engine of this type. 900 w. Engr, Lond—April 9, 1909. No. 4040 A.

New Compound Tandem Condensing Engine for Sheet Mills. Illustrated description of engine recently installed at the Eclipse Ironworks, Glasgow. Plate. 1200 w. Ir & Coal Trds Rev—April 9, 1909. No. 4044 A.

Flue-Gas Analysis.

Flue Gas Analysis. Arthur E. Jones. Abstract of paper read before the Staffordshire Ir. & St. Inst. Shows the value of analysis, giving methods of procedure and results. 3000 w. Ir & Coal Trds Rev—April 9, 1909. No. 4045 A.

Description, Installation and Economy of CO_2 Recorders. Will F. McKnight. Ills. 2500 w. Pro Soc of Ap Sci—Session 1908-1909. No. 4095 C.

Fuel Oil.

See Oil Fuel, under MARINE AND NAVAL ENGINEERING.

Fuels.

Selection of Coal for Boiler Furnaces. D. T. Randall. Read at Ill. Coal Conference. Considers the effect of furnace design, and the influence of certain characteristics of coal. 3500 w. Power—April 6, 1909. No. 3770.

The Selection and Purchase of Coal for Boiler Furnaces. D. T. Randall. Parts of an address before the Ill. Fuel Con. Suggestions for designing small steam power plants, discussing certain characteristics of coal and their influence. 2500 w. Eng News—April 8, 1909. No. 3856.

Low-Grade Fuels and the Power Plant. C. M. Ripley. Considers the relative values of steam fuels, use of coke screenings, low-grade fuels, etc. 2000 w. Elec Wld—April 1, 1909. No. 3754.

Fuel Testing.

See Analysis, under MINING AND METALLURGY, COAL AND COKE.

Mechanical Stokers.

Recent Boiler Stoking Plants Built by Carl Schenck, Darmstadt (Neuere Kesselbekohlanlagen gebaut von Carl Schenck, Darmstadt). Oskar Brix. Illustrates the arrangement of bunkers, conveying devices and mechanical stokers in several plants. Serial, 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—March 6, 1909. No. 4291 D.

Piston Speed.

A Simple Method of Determining the Acceleration of an Engine Piston (Méthode simple pour le Calcul des Accélérations du Piston d'une Machine). Armand Duchesne. Mathematical. Ills. 2000 w. Bul Sci de l'Assn des Elèves—Feb., 1909. No. 4204 D.

Safety Valves.

I. Safety Valves. Frederic M. Whyte. II. Safety Valve Capacity. Philip G. Darling. Two papers with discussion. Ills. 18300 w. Jour Am Soc of Mech Engrs—April, 1909. No. 3966 F.

Steam Pipes.

Danger from Water Hammer in Steam Pipes. Howard S. Knowlton. Gives examples of damage to pipes and valves, explaining how to avoid water hammer. Ills. 2000 w. Power—April 20, 1909. No. 4048.

Explosion of Steam Pipes Due to Water Hammer. C. E. Stromeyer. Read before the Inst. of Nav. Archts. An account of investigations giving diagrammatic representations of typical cases of water-hammer, with notes. 4500 w. Mech Engr—April 9, 1909. No. 4029 A.

Superheating.

The Properties of Superheated Steam. Henry T. Eddy. Gives results of recent experimental investigations as to the specific heat of superheated steam, aiming to place the information in a form readily applicable. Charts. 1500 w. Minn Engr—March, 1909. No. 4065 C.

Turbine Nozzles.

The Design of Steam Turbine Nozzles (Die Düsen der Dampfturbinen und die Berechnung ihrer Dimensionen). J. W. Haeussler. Theoretical and mathematical. Serial, 1st part. 3000 w. Die Turbine—March 20, 1909. No. 4272 D.

Turbine Operation.

Windage Losses in Steam Turbines with Partial Admission (Ventilationsverlust in Dampfturbinen mit Teilbeaufschlagung). W. J. Jasinsky. Mathematical discussion and report of investigations. Ills. Serial, 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—March 27, 1909. No. 4297 D.

Turbines.

Steam Turbines. H. A. Hussey. An illustrated explanation of types and their operation. 2500 w. Cal Jour of Tech—March, 1909. No. 3948.

The Field and Future of the Low-Pressure Steam Turbine. Ira N. Hollis. This second paper of a series considers the development and applications of low-pressure turbines to stationary service in America. Ills. 2500 w. Engineering Magazine—May, 1909. No. 4338 B.

Low Pressure or "Exhaust" Steam Turbines. J. A. Moyer. Discusses their efficiency and applications. 2200 w. Mich Tech—Feb., 1909. No. 4071 D.

The French Thomson-Houston Company's Curtis Turbine (Die Curtisturbinen der französischen Thomson-Houston-Gesellschaft, Paris). W. Koeniger. Illustrated detailed description. Serial, 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—March 10, 1909. No. 4270 D.

TRANSPORTING AND CONVEYING.

Cableways.

A Bleichert Tramway in the Argentine Cordilleras (Les Cordillères du Nord de l'Argentine rendues accessibles par une Voie aérienne du Système Bleichert). J. E. Giraud. Illustrated description of the Chilecito installation. 2000 w. Rev de Métal—March, 1909. No. 4214 E + F.

See also Construction, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Coal Handling.

See Mechanical Stokers, under STEAM ENGINEERING.

Cranes.

The Electrical Equipment of Cranes. John Brentnall Duckitt. A discussion of present practice and of the advantages claimed. Gen. discussion. 6 plates. 9000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1909. Serial, 1st part. No. 3807 N.

Comparison of Large Power Fixed and Floating Cranes. Illustrates and describes types of floating cranes, showing their usefulness, especially in shipbuilding, and their advantage in cost. 1200 w. Engr, Lond—April 9, 1909. No. 4042 A.

Giant Cranes. Harold P. Hobart. Reviews the past and present types of these machines in the great seaports. 1500 w. Yale Sci M—April, 1909. No. 4374 C.

Jacks.

Tests of a Six-Ton Jack. G. A. Glick. Brief report of test to obtain the efficiency. 400 w. Power—April 13, 1909. No. 3922.

Material Handling.

Modern Material-Handling Machinery for Industrial Plants. A. G. A. Schmidt. The present article illustrates and describes types of hoisting machinery. 6000 w. Ind Engng—April, 1909. Serial, 1st part. No. 4077 C.

MISCELLANY.

Aeronautics.

The Aero Exhibition. A review of exhibits at Olympia. Ills. 2500 w. Engng—March 26, 1909. No. 3788 A.

The Aero Exhibition. Illustrates and describes exhibits at Olympia. 6500 w. Motor Car Jour—March 27, 1909. No. 3772 A.

The Development of Aerial Navigation. Henry Harrison Suplee. An interesting illustrated review of the recent successes

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with flying machines. 6000 w. Cassier's Mag—April, 1909. No. 3634 B.

Notes on the Existing Types of Dirigible Balloons (Beschouwingen over bestaande Typen van bestuurbare Luchtschepen). P. J. Post van der Steur. A review of progress in airship construction and of the fundamental theories. Ills. 12500 w. De Ingenieur—March 6, 1909. No. 4209 D.

Flight of the "Zeppelin I." An account of recent performances of this German airship. 1200 w. Sci Am Sup—April 17, 1909. No. 3947.

The Theory of Aeroplanes (Essai de Théorie des Aéroplanes). P. Lauriol. An attempt to formulate the fundamental principles of aviation. Ills. Serial, 1st part. 5600 w. Génie Civil—March 27, 1909. No. 4236 D.

The Ravaud Aero Hydroplane. Illustrated description of a new type of aeroplane adapted to rise from water. 600 w. Sci Am Sup—May 1, 1909. No. 4333.

How to Build a Chanute-Type Glider. Illustrated directions. 1500 w. Sci Am—April 24, 1909. No. 4111.

Oxygen.

The Commercial Production of Oxygen. Dr. Alfred Gradenwitz. Illustrated description of the improved Claude process. 1500 w. Sci Am Sup—April 10, 1909. No. 3843.

Progress.

Some Recent Advances in Mechanical Engineering. Carl C. Thomas. Considers development in steam turbines, gas engines, progress in cutting metals, and various other developments. Ills. 4000 w. Wis Engr—Feb., 1909. No. 4314 D.

Textile Mills.

The Cotton Industry in India. John Wallace. An illustrated account of the conditions in India and the development of this industry, and the application of modern methods. 4500 w. Cassier's Mag—April, 1909. No. 3635 B.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

Coal Sampling and Analysis. N. W. Lord. Parts of an address before the Ill. Fuel Con. Outlines the analytical and calorimetric tests needed in the laboratory and considers methods of sampling. 2500 w. Eng News—April 8, 1909. No. 3852.

Analysis of the Subject of Coal Analysis. N. W. Lord. Discusses the values of the methods used in analyzing. 4000 w. Power—April 13, 1909. No. 3010.

Coal Cutting.

Mining Coal with Machines in England. George R. Dixon. Gives detailed costs, showing that the economy is due to the increase in the value of the coal produced, rather than reduction in working costs. 3000 w. Eng & Min Jour—April 17, 1909. No. 4007.

Conservation.

Needs for Conservation of Our Coal Deposits. J. V. Thompson. Gives statistics showing the rate of exhaustion. 1000 w. Pro Am Min Cong—1908. No. 4132 N.

Conservation in the Mining Industry. Frank M. Osborne. Especially considers the coal fields and the need of economic methods. 1500 w. Pro Am Min Cong—1908. No. 4122 N.

Conservation in the Coal Industry. John Mitchell. Discusses fuel resources and the protection of human life in mines. 4500 w. Pro Am Min Cong—1908. No. 4134 N.

Conservation in the Coal Industry, Protection of Life and Prevention of Waste. Glenn W. Traer. A discussion of present conditions, and the remedies needed. 5200 w. Pro Am Min Cong—1908. No. 4130 N.

See also Natural Resources, under INDUSTRIAL ECONOMY.

Electric Power.

Mining Motors and Switchgear. William Maurice. A lecture at the University College, Nottingham, on the available apparatus for electrical applications in mines. Ills. 6500 w. Ir & Coal Trds Rev—April 9, 1909. No. 4043 A.

Notes on Safety of Working Electrical Plants in Coal Mines. Sidney A. Simon. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Reviews experience since the new rules of the Home Office have been in force, and gives an account of tests made in Germany and the results. 5000 w. Elec Engr, Lond—March 26, 1909. Serial, 1st part. No. 3777 A.

Explosions.

Mine Accidents. Sim. Reynolds. Discusses some of the little things that cause them. 2500 w. Mines & Min—April, 1909. No. 3673 C.

Illinois.

The Carterville Coal Field, Southern Illinois. R. S. Moss. Illustrated historical review of the development. 1500 w. Min Wld—April 10, 1909. No. 3875.

Mine Ventilation.

An Inquiry into the Ventilation of Coal Mines and the Methods of Examin-

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ing for Firedamp. Information from Prof. Cadman's report of investigations made for the Royal Commission. 3000 w. Ir & Coal Trades Rev—March 26, 1909. Serial, 1st part. No. 3794 A.

The Ventilation of Coal Mines. Report of the Royal Commission on an inquiry into the ventilation and methods of examining for firedamp, made by John Cadman and E. B. Whaley. 8500 w. Col Guard—April 2 and 9, 1909. Serial, 2 parts. No. 4033 each A.

Mining.

Problems of the Coal Mining Industry. Dr. J. A. Holmes. Brief remarks on a few problems such as accidents, smoke, waste, etc. 1000 w. Pro Am Min Cong—1908. No. 4125 N.

Pocahontas Region Mining Methods. H. H. Stock. Illustrated detailed description of the standard methods of development. 3000 w. Mines & Min—April, 1909. No. 3672 C.

Montana.

The Coal-Mining Industry of Montana. J. P. Rowe. Illustrated review of various properties and the methods employed. 4000 w. Eng & Min Jour—April 24, 1909. No. 4176.

New Zealand.

Methods of Mining Coal in New Zealand. Sidney Fry. Illustrated detailed description of the Westport-Sockton Colliery, being developed along American lines. 2000 w. Eng & Min Jour—April 10, 1909. No. 3869.

Safety Lamps.

Early Safety Lamps (Die ersten Sicherheitslampen). W. Niemann. Describes early attempts to produce a practical safety lamp. Ills. 2000 w. Glückauf—March 13, 1909. No. 4264 D.

Sampling.

See Analysis, under COAL AND COKE.

Scotland.

The Clyde Valley Coalfield. David Ferguson. A geological study of the coalfields and deposits of Scotland. 2500 w. Col Guard—April 16, 1909. No. 4199 A.

Seismograph Station.

The Seismograph Station of the Westfalian Coal Company in Bochum (Die Erdbebenstation der Westfälischen Berggewerkschaftskasse in Bochum). L. Mintrop. Detailed description of the station and its equipment. Ills. Serial, 1st part. 3500 w. Glückauf—March 13, 1909. No. 4262 D.

United States.

Problems of the Coal Industry. Alexander Dempster. Discusses the establishment of a mining bureau, accidents, and related subjects. 3000 w. Pro Am Min Cong—1908. No. 4139 N.

The Coal Fields of the United States. Marius R. Campbell and Edward W. Parker. Gives classification and description, with remarks on duration of supply and waste. 3000 w. Bul Am Inst of Min Engrs—April, 1909. No. 4085 F.

West Virginia.

The Barren Zone of the Northern Appalachian Coal Field and Its Relation to Pittsburgh's Industries. Dr. I. C. White. Considers the problem of coal shortage and discusses the waste and the remedies. 4000 w. Pro Am Min Cong—1908. No. 4131 N.

COPPER.

Australia.

Methods of Copper Mining. H. Lipson Hancock. Compares Australia with America and Europe. 1800 w. Aust Min Stand—March 17, 1907. No. 4187 B.

Briquetting.

See same title, under ORE DRESSING AND CONCENTRATION.

Lake Superior.

See Smelting, under COPPER.

Mexico.

The Cananea Consolidated Copper Co. in 1908. L. D. Ricketts. Report of operations, development work, etc. 6000 w. Eng & Min Jour—April 3, 1909. No. 3726.

Nevada.

The Nevada-Douglas Copper Properties, Nev. W. S. Zehring. Illustrates and describes the geology of this mining district. 1800 w. Min Wld—April 17, 1909. No. 4021.

Nova Scotia.

Property of the Lake Copper Mining Co., Limited, at Copper Lake, Antigonish, N. S. John W. McLeod. Illustrated detailed description of this property and its development. 2000 w. Can Engr—April 16, 1909. No. 3994.

Smelter Fumes.

Problems in the Utilization of Smelter Fumes. Joseph H. Hart. Discusses principally the production and utilization of sulphuric acid. 2500 w. Min Wld—April 3, 1909. No. 3744.

Smelters.

The Yampa Smelting Co.'s 1000-Ton Converter. Charles C. Christensen. Illustrated description of this plant, located in Bingham Canyon, Utah. 2000 w. Min Wld—April 3, 1909. No. 3743.

Smelting.

Costs of Lake Superior Smelting. L. S. Austin. Gives a summary of production and costs. 1200 w. Min & Sci Pr—April 24, 1909. No. 4348.

Utah.

Boston Consolidated, Bingham, Utah. Courtenay De Kalb. Describes the deposits, methods of mining and handling. Ills. 2000 w. Min & Sci Pr—April 17, 1909. No. 4149.

The Utah Copper Mine. Courtenay de

Kalb. Describes the development of a large low-grade deposit. Ills. 4500 w. Min & Sci Pr—April 10, 1909. No. 3971.

GOLD AND SILVER.

Amalgamation.

Electrochemical Amalgamation and Lixiviation. Elmer Ellsworth Carey. Calls attention to improvements that can be made by employing electrochemical action in connection with lixiviation and amalgamation of gold ores. 2200 w. Min Wld—April 17, 1909. No. 4018.

Assaying.

The Salt Lake, Utah, Government Assay Office. Leroy A. Palmer. Illustrated description of the methods and equipment. 1500 w. Min Wld—April 24, 1909. No. 4179.

Australia.

The Mount Morgan Mine, Central Queensland. J. Bowie Wilson. An illustrated account of this enormous body of gold ore which has produced $70,000,000, the methods of mining, etc. 4000 w. Eng & Min Jour—April 10, 1909. No. 3868.

Water Losses at Broken Hill. T. H. Palmer. Abstract of a paper before the Sci. Soc. of Broken Hill. A consideration of the water losses in a district where the water supply is a problem. 2500 w. Eng & Min Jour—April 24, 1909. No. 4177.

See also Accidents, under MINING: and Gold Milling, under ORE DRESSING AND CONCENTRATION.

Cobalt.

The Nipissing Mine, Cobalt, Ont., as It Is To-Day. Alex. Gray. Information in regard to production. 2000 w. Min Wld—April 24, 1909. No. 4180.

Colorado.

See Ore Deposits, under MISCELLANY.

Cyaniding.

Cyanide Lixiviation by Agitation. Walter M. Brodie. Illustrated description of the Pachuca tank with circulation pipes, explaining advantages. 1000 w. Eng & Min Jour—April 3, 1909. No. 3724.

Cyaniding Black Hills "Blue Ores." B. D. O'Brien. Report of experiments in grinding to different degrees of fineness and roasting, and with cyanide and other chemical treatments. 4500 w. Mines & Min—April, 1909. No. 3676 C.

Cyanidation of Parral Silver Ores. H. T. Willis. An account of the cyanidation of silver ores in Mexico. 1500 w. Min & Sci Pr—April 3, 1909. No. 3828.

Milling and Cyaniding Practice at El Oro, Mex. Claude T. Rice. Illustrated description of interesting features, including the tailings wheels, Burt filters, immense cone settler, and the continuous agitation. 6000 w. Eng & Min Jour—April 3, 1909. No. 3722.

Dredging.

Development of Dredges for Placer Deposits. George B. Massey, II. The evolution of the dredge is reviewed. Ills. 1500 w. Eng & Min Jour—April 24, 1909. No. 4174.

Hydraulic Dredging for Gold-Bearing Gravels. Henry G. Granger. Describes an effective suction dredge, discusses special conditions of gold-dredging, reviews the history, and gives conclusions. Gives specifications for a hydraulic gold-dredge. Ills. 7000 w. Bul Am Inst of Min Engrs—April, 1909. No. 4088 F.

France.

The Three Producing Gold Mines of France. E. Walch. Information, with a brief description of the reduction plants for these refractory ores. Ills. 1800 w. Eng & Min Jour—April 17, 1909. No. 4005.

Mexico.

Mining in Alamos and Arteaga Districts. George M. Bloomer. Illustrated review of this part of northwestern Mexico. 1700 w. Eng & Min Jour—April 3, 1909. No. 3725.

Traveling in Western Chihuahua, Mexico. Frederick H. Morley. Illustrated notes on a trip to the Ocampo District. 1800 w. Eng & Min Jour—April 3, 1909. No. 3727.

Geology of the Guanajuato District, Mexico. C. W. Botsford. General geo- Mexico. C. W. Botsford. General description of the geology of the region, with notes on veins and ore occurrences. Ills. 3500 w. Eng & Min Jour—April 3, 1909. No. 3723.

Placers.

Placer Mining Industry on the Pacific Coast. Dennis H. Stovall. Illustrated description of the district and report of output. 700 w. Min Wld—April 17, 1909. No. 4020.

Rand.

Amalgamation of Four Large Rand Producers. Ralph Stokes. Explains the proposed scheme, giving short descriptions of the mines included in the amalgamation. Plan. 1200 w. Min Wld—April 3, 1909. No. 3745.

The Distribution of the Gold Produced on the Rand. T. Kirke Rose. Statistics of the first rough distribution of the gold produced in South Africa. 2500 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1909. No. 4023 E.

See also United States, under MISCELLANY.

Tasmania.

King Island, North-West Coast, Tasmania. Donald Clark. Describes features of the country, and mineral deposits of gold and tin oxide. 1000 w. Aust Min Stand—March 10, 1909. Serial, 1st part. No. 4186 B.

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IRON AND STEEL.

Assaying.

Preliminary Tests from the Open Hearth Steel Furnace. C. W. Danforth. Read before the Pittsburg Sec. of the Am. Chem. Soc. Shows how speed and accuracy may be attained in laboratory practice. 3000 w. Ir Age—April 8, 1909. No. 3821.

Austria.

The History of Iron in the Interior of Austria (Zur Geschichte des Eisens in Inner-Oesterreich). L. Beck. A brief general review. Serial, 1st part. 5300 w. Stahl u Eisen—March 10, 1909. No. 4250 D.

Bessemer Process.

The New Basic Bessemer Plant at the Burbach Works (Das neue Thomasstahlwerk der Burbacher Hütte). F. Schroeder. Illustrated description. 3800 w. Zeitschr d Ver Deutscher Ing—March 20, 1909. No. 4295 D.

Blast-Furnace Gas.

The Problem of Waste Heat Utilization in Iron Works. John B. C. Kershaw. Shows an outlet for electric power in all large iron smelting works. 1500 w. Ir & Coal Trds Rev—April 2, 1909. No. 3917 A.

Blast-Furnace Linings.

Firebrick for Blast Furnaces. Discusses defects which shorten the life of linings, and the remedies. 2000 w. Ir Age—April 29, 1909. No. 4327.

California.

An Iron Deposit in the California Desert Region. Charles Colcock Jones. Illustrates and describes a deposit of soft, or semi-hard hematite ore. 2500 w. Eng & Min Jour—April 17, 1909. No. 4003.

Dry-Air Blast.

Economics in the Manufacture of Iron and Steel. G. B. Waterhouse. Describes important lines along which economies are being effected in this industry. The present article deals with the Gayley dry blast process. Ills. 4000 w. Engineering Magazine—May, 1909. No. 4340 B.

Electro-Metallurgy.

Reduction of Iron Ore in the Electric Furnace. Abstract of a paper by Remo Catani, who has recently investigated the possibilities of the electric furnace in iron ore reduction in comparison with the blast furnace. 1700 w. Elec-Chem & Met Ind—April, 1909. No. 3659 C.

The Production of Pig Iron at the Electric Furnace and the Industrial Utilization of Pyrite Residue. F. E. Carcano. Gives an interesting case in which the electric furnace can well hold its own against the blast furnace, with a general comparison. 2000 w. Elec-Chem & Met Ind—April, 1909. No. 3660 C.

The Girod Process (Electrométallurgy du Fer et de l'Acier, Procédés Girod). Describes the engine plant, the materials treated, and the products, particularly the ferro-alloys. Ills. 5000 w. Rev d'Electrochim et d'Electrométal—Jan., 1909. No. 4210 F.

India.

The Development of the Iron and Steel Industry in India. Information concerning this industry. 1000 w. Ir & Coal Trds Rev—April 16, 1909. No. 4307 A.

Lake Superior.

Cost of Pig Iron Made from Lake Superior Ores. J. R. Finlay. Considers general costs, and the activities of the U. S. Steel Corporation. Cost of transportation greater than cost of mining. Map. 8000 w. Eng & Min Jour—April 10, 1909. No. 3867.

Estimation of Lake Superior Iron Ore Reserves. George E. Edwards. Gives opinions of a number of experts as to the almost boundless extent of the deposits, and discusses matters that affect the cost of mining. 2000 w. Min Wld—April 10, 1909. No. 3876.

Open Hearth.

Producer Gas Fired Furnaces in the Iron and Steel Industries. Oskar Nagle. Illustrated descriptions of types of furnaces in common use. 1500 w. Ir Trd Rev—April 8, 1909. Serial, 1st part. No. 3825.

See also Assaying, under IRON AND STEEL.

Production.

The World's Production and Consumption of Iron Ore. Statistics from a recently issued paper by the British Board of Trade. 4500 w. Ir & Coal Trds Rev—April 16, 1909. No. 4308 A.

Rolling Mills.

Analysis of Power Consumption in a Roll Pass. G. A. Merkt. Mathematical analysis, with diagrams. 1200 w. Ir Trd Rev—April 22, 1909. No. 4147.

The Automatic Manufacture of Steel Rails. Illustrated description of methods involving the use of heavy automatic machinery. 3000 w. Am Mach—Vol. 32, No. 17. No. 4351.

Rolls for Channel and T Profiles (Die Anordung der Kaliber für [-Eisen und hochstegige T-Profile). L. Schaefer. Discusses the dimensioning of the grooves. Ills. 1700 w. Stahl u Eisen—March 24, 1909. No. 4253 D.

Steel Works.

Beardmore's Steel Works at Parkhead, Glasgow. Illustrated detailed description of a newly equipped and organized factory for the production of guns, armor, etc. 5500 w. Engng—April 2, 1909. Serial, 1st part. No. 3905 A.

United States.

The Iron-Ore Supply of the United States. C. Willard Hayes. Classifies and describes the commercial iron ores, and gives the writer's conclusions as to dura-

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tion of the supply. 2200 w. Bul Am Inst of Min Engrs—April, 1909. No. 4086 F.

The Iron Industry of the Pacific Northwest. H. Cole Estep. Information in regard to the iron deposits of this region and their development. Ills. 2200 w. Min Engr—March, 1909. No. 4063 C.

LEAD AND ZINC.

Missouri.

History of Southeast Missouri Lead District. Otto Ruhl. Illustrated historical review and description. 2500 w. Min Wld —April 17, 1909. Serial, 1st part. No. 4017.

Zinc Tariff.

Tariff on Zinc Ores. S. Duffield Mitchell. Discusses the need of protection for zinc ores. 6600 w. Pro Am Min Cong—1908. No. 4137 N.

MINOR MINERALS.

Aluminium.

Aluminium. J. A. McKenzie Williams. Information in regard to production, and methods of reduction, reviewing the past history of development and present uses. Ills. 5500 w. Ap Sci—March, 1909. No. 4091 C.

Asbestos.

Quebec Asbestos: World's Supply Controlled. Alex. Gray. Information in regard to output, value, profits, etc. 3500 w. Min Jour—April 3, 1909. No. 3904 A.

Carborundum.

See Grinding Wheels, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Cement.

The Manufacture of Portland Cement. William M. Kinney. A brief historical review, with description of modern methods of manufacture. Ills. Discussion. 6000 w. Pro Engrs' Soc of W Penn—March, 1909. No. 3814 D.

Diamonds.

Kimberlite Rock and the Origin of Diamonds. F. W. Voit. Gives a description of the diamond-bearing rocks, and a study of the deposits. 3000 w. Eng & Min Jour —April 17, 1909. No. 4004.

Fluorspar.

Kentucky Fluorspar and Its Value to the Iron- and Steel-Industries. F. Julius Fohs. Describes the Memphis mine, near Marion, Ky., discussing the origin of the deposits, describing the fluorspar mills, and explaining the value of the product in the metallurgy of iron and steel. 5000 w. Bul Am Inst of Min Engrs—April, 1909. No. 4089 F.

Oil.

Practical Determination of the Commercial Value of Illuminating Oils (Détermination pratique de la Valeur commerciale des Pétroles destinés à l'Eclairage). Eugène Marquet. Illustrated description of methods of determining the illuminating power of petroleum oils. 3500 w. Tech Mod—March, 1909. No. 4231 D.

Rare Elements.

A Brief Statement of the Rising Importance of the Rare Elements. Reviews the remarkable progress in the use of tungsten, vanadium, uranium, monazite, molybdenite and other rare minerals. 3000 w. Pro Am Min Cong—1908. No. 4136 N.

Salt.

Leaching Brine from Salt Mines (Solererzeugung durch Berieselung der Werksulme). Karl Schraml. Describes the methods used at Aussee, Austria. Ills. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—March 6, 1909. No. 4258 D.

Tin.

Present Position of Bolivian Tin Mines. Gilmour E. Brown. Information concerning the present condition of the tin mining industry. 1000 w. Min Jour—March 27, 1909. No. 3784 A.

Mount Bischoff Tin M. Co., Tasmania. J. D. Millen. Illustrates and describes the hydro-electric plant for supplying electric power for mine, mills, and electric traction. 2200 w. Aust Min Stand—March 10, 1909. Serial, 1st part. No. 3988 B.

Tin in Pérak (L'Etain dans l'Etat de Pérak). L. Giraud. An exhaustive review of the deposits, their history, mining, ore dressing, etc. Ills. 23000 w. Mem Soc Ing Civ de France—Jan., 1909. No. 4202 G.

See also Tasmania, under GOLD AND SILVER.

Uranium.

The Radioactivity of the Raw Materials and Middle and End Products of the Imperial Uranium Dye Works at St. Joachimstahl (Ueber die Radioaktivität der in der k. k. Uranfarbenfabrik zu St. Joachimstahl erzeugten Roh- Zwischen- und Endprodukte). Josef Step. An account of investigations. Ills. Serial, 1st part. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen —March 13, 1909. No. 4259 D.

MINING.

Accidents.

The Disasters at the Mount Morgan Mine, Queensland. The report of the Board of Inquiry, describing the mine and methods, recent accidents and their causes with recommendations. 7500 w. N Z Mines Rec—Feb. 16, 1909. No. 3885 B.

Boring.

The Choice of Boring Methods, with Reference to Their Applications, Capacity and Cost (Die wahl des Bohrsysteme unter Berücksichtigung ihres Anwendungsgebietes, ihrer Leistungsfähigkeit und Anschaffungskasten). Anton Pois. Serial, 1st part. 1800 w. Oest Zeitschr f Berg- u Hüttenwesen — March 27, 1909. No. 4260 D.

Drills.

Comparative Tests of Large and Small

Hammer Rock-Drills. J. B. Lippincott. Gives description of tests, with tabulated results. 800 w. Eng News—April 22, 1909. No. 4166.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Hoisting.

Electric Hoisting Plants (Electrische Ophaalwerktuigen). J. H. D. Wagener. Describes the installation at the Wilhelmina mine in Holland. Ills. 6000 w. De Ingenieur—March 27, 1909. No. 4377 D.

Electric Power.

Electricity in Mines. T. J. McKavanagh. Read before the Min. Soc, of Nova Scotia. A review of modern and economical applications of electricity to mining. 2500 w. Can Min Jour—April 1, 1909. No. 3764.

The Installation of Electricity in Mines. W. A. Thomas. Deals with the manner of installation and operation of electric conductors and apparatus in underground workings. 3000 w. Pro Am Min Cong—1908. No. 4135 N.

Explosives.

See Mine Gas, under MINING.

Haulage.

Gravity Planes. A. W. Evans. Illustrates and describes track and haulage arrangements in use in Pennsylvania, Virginia, Kentucky and Tennessee. 2000 w. Mines & Min—April, 1909. No. 3674 C.

Labor.

Arbitration as a Factor in the Mining Industry. Two papers on this subject by Judge George Gray, and by Thomas L. Lewis. 3000 w. Pro Am Min Cong—1908. No. 4138 N.

The Importance of Arbitration as a Factor in the Advancement of the Mining Industry. Hon. Carroll D. Wright. Shows the benefits of this method of adjusting difficulties. 1800 w. Pro Am Min Cong—1908. No. 4120 N.

Machinery.

Lowering a Large Pump into a Mine. George J. Young. Illustrated description of method employed at the Ward shaft, Virginia City, Nevada. 800 w. Eng & Min Jour—April 17, 1909. No. 4008.

Mine Gas.

The Estimation of Carbon Monoxide in Mine Gas. E. H. Weiskopf. Explains the method of sampling mine air, and considers the effects of explosions, the methods of firing, and the nature and composition of the explosive. 5000 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1909. No. 4022 E.

Shafts.

Concrete-Lined Mine Shafts at Filbert, Pa. Illustrated detailed description of methods used. 1000 w. Eng News—April 8, 1909. No. 3855.

See also Timbering, under MINING.

Shaft Sinking.

Modern Shaft Sinking. Francis Donaldson. Discusses features of contracts for such work, supplies and machinery needed. 3200 w. Mines & Min—April, 1909. No. 3671 C.

Shaft-Sinking at the Horden Colliery, South-East Durham. John Joseph Prest. Read before the Inst. of Civ. Engrs. Illustrated description of the work. 3000 w. Ir & Coal Trds Rev—April 2, 1909. Serial, 1st part. No. 3914 A.

Timbering.

Reinforced Concrete Shaft Linings (Die Bedeutung des Eisenbetons für den Schachtausbau). Dr. Färber. Mathematical discussion of their strength and design with notes on their cost. Ills. 1700 w. Glückauf—March 13, 1909. No. 4263 D.

Some Recent Applications of Concrete in Mining (Einige neuere Betonierungsverfahren und ihre Anwendungsgebiete im Bergbau). R. Scharf. Describes several applications in tunnel and shaft lining. Ills. 1800 w. Glückauf—March 27, 1909. No. 4265 D.

Timber Preservation.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Tunnelling.

See Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

ORE DRESSING AND CONCENTRATION.

Briquetting.

The Purple Ore Briquetting Plant of the Helsingborg Kepparwerks Aktiebolag. Prof. G. Franke. Abstract trans, from *Glükauf*. Illustrates and describes this part of a large copper works in Sweden. 2500 w. Ir & Coal Trds Rev—April 2, 1909. No. 3916 A.

Drying.

Dryers and Drying. W. B. Ruggles. Discusses artificial methods for the removal of moisture. 1200 w. Cassier's Mag—April, 1909. No. 3637 B.

Gold Milling.

The 100-Stamp Desert Mill at Millers, Nevada. Al. H. Martin. Illustrated description of the mill for treating Tonopah ores. 1500 w. Min Wld—April 24, 1909. No. 4178.

Metallurgical Treatment of Mount Morgan Ores. J. Bowie Wilson. Describes processes for gold recovery developed to suit the peculiarities of the ores. Ills. 800 w. Eng & Min Jour—April 24, 1909. No. 4175.

See also Australia, and Cyaniding, under GOLD AND SILVER.

Magnetic Separation.

See Magnetic Separators, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Silver Milling.

See Cyaniding, under GOLD AND SILVER.

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Stamp Mills.

Graphical Determination of the Form of Stamp Cams (Zeichnerische Ermittlung der Gestalt von Aufwerfdaumen). M. Herrmann. Illustrated description of method. 1500 w. Zeitschr d Oest Ing u Arch Ver—March 26, 1909. No. 4281 D.

MISCELLANY.

Alaska.

Alaska and Its Mineral Resources. Alfred H. Brooks. Information concerning the mineral resources and their development, transportation, etc. 4000 w. Pro Am Min Cong—1908. No. 4143 N.

Transportation Facilities in Alaska and the Yukon. W. M. Brewer. Information relating to means of transportation, distances, routes, ports, etc. Maps. 2000 w. Min & Sci Pr—April 3, 1909. No. 3827.

Alloys.

The Silicon-Magnesium Series (Sur le Système Silicum-Magnésium). P. Lebeau and P. Bossuet. A metallographic study of the alloys of these two metals. Ills. 1800 w. Rev de Métal—March, 1909. No. 4212 E + F.

The Alloys of Antimony (Les Alliages d'Antimoine). M. A. Portevin. Summarizes the results of Prof. Jammann's researches on the alloys of antimony with bismuth, calcium, cadmium, cobalt, chromium, iron, etc. Ills. 6000 w. Rev de Métal—Feb., 1909. No. 3308 E + F.

America.

The Mineral Wealth of America. R. W. Raymond and W. R. Ingalls. A general survey of the known mineral deposits, their development, and their influence on civilization. 5500 w. Bul Am Inst of Min Engrs—March, 1909. No. 3469 F.

Arizona.

Mining and Mineral Resources of Arizona. Frank Cox. 1500 w. Pro Am Min Cong—1908. No. 4127 N.

Arkansas.

Mineral Resources of Arkansas. A. W. Estes. Brief account of deposits of zinc, lead, coal, beauxite, marble, granite, and other minerals of value. 2000 w. Pro Am Min Cong—1908. No. 4129 N.

Australia.

Distribution of Minerals on the Pacific Littoral. Abstract of a lecture by Dr. Logan Jack, before the Australasian Assn. for the Adv. of Science. Discusses the geographical distribution of minerals and its influence on commerce. 2500 w. Aust Min Stand—Feb. 10, 1909. No. 3142 B.

Mines and Mining Plant in Australia. A statement of the localities of the chief metals and a short review of their development. 4500 w. Min Jour—Feb. 20, 1909. No. 2887 A.

Canada.

The Mineral Production of Canada in 1908. John McLeish. Review giving tabulated statistics and comments. 2500 w. Eng & Min Jour—March 13, 1909. No. 3121.

China.

Mining in Northern China. F. L. Cole. A general review of the present condition of the mining industry. Map. 2000 w. Min & Sci Pr—April 24, 1909. No. 4347.

Colombia.

Economic Conditions in Colombia. F. Lynwood Garrison. Maps and information concerning climate, mining laws, land titles, labor conditions, etc. 2000 w. Min & Sci Pr—April 17, 1909. No. 4148.

Earthquakes.

Geological Fractures in the Calabria-Sicily Region (Fratture geologische della Regione Calabro Sicula). E. Cortese. Discusses the geological structure with reference to the recent earthquakes. Ills. 6600 w. Ann d Soc d Ing e d Arch Ital —March 1, 1909. No. 4241 F.

Geology.

Meteor Crater. John B. Hastings. Illustrated account of an interesting phenomenon in Arizona. 2000 w. Min & Sci Pr—April 10, 1909. No. 3972.

Japan.

The Mining Industry in the Hokkaido, Japan. Report of British Vice-Consul Parlett, giving information of mines, conditions, wages, etc. 2500 w. Min Jour—April 10, 1909. No. 4032 A.

Mexico.

Protection of Mexican Investors. F. J. H. Merrill. A discussion of mining titles and points that have been matters of dispute. 2000 w. Min & Sci Pr—April 3, 1909. No. 3829.

New Zealand.

Outline of New Zealand Geology. James Park. A general review of the geology of the country. The present number deals mainly with the physiographic features. 3000 w. N Z Mines Rec—Feb. 16, 1909. Serial, 1st part. No. 3883 B.

Ore Deposits.

Occurrence of Ore Deposits in Mineral Belts. Arthur Lakes. An illustrated geological study. 2200 w. Min Wld—April 10, 1909. No. 3874.

The Ore Occurrence and Origin of Cave Mines. Arthur Lakes. Illustrates and describes remarkable occurrences in Colorado. 1600 w. Min Wld—April 17, 1909. No. 4019.

Ores Formed By Magmatic Segregation. F. Lynwood Garrison. Reviews the theories advanced in regard to ore deposits, especially considering iron ores and studying the process of magmatic segregation in meteorites. 6000 w. Min & Sci Pr—March 27, 1909. No. 3678.

Papua.

Mining District, Port Moresby, Papua.

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P. N. Charpentier. Deals with the geological features and the purchase of ore. 2000 w. Aust Min Stand—March 3, 1909. No. 3882 B.

Peru.

The Mineral Features of Tayacaja, Ancaraes, and Huancavelica, Peru. Enrique J. Dueñas. The present article describes the province of Tayacaja. 2500 w. Min Jour—March 27, 1909. Serial. 1st part. No. 3785 A.

Santo Domingo.

Some Investigations of Santo Domingo Minerals. C. W. Kempton. Illustrated article describing the topography, climate, and features of the island, and reporting the results of explorations. Gold, lead, copper, and amber were found. 1000 w. Min Wld—March 27, 1909. No. 3746.

Transportation.

Transportation in Its Relation to the Mining Industry. Dr. James Douglas. Discusses the interdependence of the transportation and mining industries, and the intense activity that is using up the natural resources of the country. 4500 w. Pro Am Min Cong—1908. No. 4123 N.

Transportation of Mineral Products. Edward H. Harriman. Shows the importance of mine products as a factor in transportation, discussing their relation to the railroads, and related subjects. 5000 w. Pro Am Min Cong—1908. No. 4119 N.

United States.

Distribution of the Nation's Mineral Wealth. George Otis Smith. Remarks on production statistics and the effect of the wide distribution of raw materials. 1200 w. Pro Am Min Cong—1908. No. 4140 N.

Relation of the Federal Government to Mining. Charles Dick. Shows the necessity of work for the prevention of accidents, loss of life, and prevention of waste, and other problems of mining and metallurgy, urging investigation by the U. S. Government. 8000 w. Pro Am Min Cong—1908. No. 4118 N.

The Federal Government in Its Relation to the Mining Industry. Hon. James Rudolph Garfield. Reviews what the government has done and proposes to do in work connected with the mining industry. 3500 w. Pro Am Min Cong—1908. No. 4124 N.

The Duties of the Federal and State Governments in Relation to the Mining Industry. W. F. Englebright. Remarks favoring the establishment of a mining bureau. 1200 w. Pro Am Min Cong—1908. No. 4142 N.

The Duties of the Federal and State Governments in Relation to the Mining Industry. George Harrison. Recommends the establishment of a National Bureau of Mines, to investigate mining conditions and secure information pertaining to safe and economic mining. 3000 w. Pro Am Min Cong—1908. No. 4121 N.

How It Strikes an American. T. Lane Carter. A comparison of mining conditions in America and South Africa. Ills. 3000 w. Min & Sci Pr—March 27, 1909. Serial, 1st part. No. 3677.

Utah.

Some Utah Mineral Deposits and Their Metallurgical Treatment. Robert H. Bradford. Reviews the present state of Utah's mining and metallurgical industries. 5500 w. Pro Am Min Cong—1908. No. 4126 N.

Virginia.

The Mineral Resources of Virginia. E A. Schubert. A general discussion of their economic value. 8500 w. Pro Am Min Cong—1908. No. 4128 N.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

The Railway, the Man, and the Accident. J. O. Fagan. From a paper before the Am. Anti-Accident Assn. A discussion of the responsibility for accidents of the American railway employee. 2000 w. R R Age Gaz—April 30, 1909. No. 4370.

Publicity for Railroad Accidents. W. L. Park. Considers means of reducing avoidable accidents. Also general discussion. 16000 w. Pro W Ry Club—March 12, 1909. No. 4083 C.

Signaling.

Railway Signaling. James B. Latimer. Illustrated detailed description of the operation of interlocking machines. 5000 w. Sig Engr—April, 1909. Serial, 1st part. No. 3999.

Movement of Trains on Single Track Without Train Orders. Synopsis of paper by George S. Pflasterer, read before the Nashville Assn. of R. R. Officers. Describes the main features of a successful system in operation between Wauhatchie and Chattanooga, in service 21 years. 1500 w. Sig Engr—April, 1909. No. 4000.

The Weverton Signaling Installation on the Baltimore and Ohio Railroad. Illustrates and describes a new interlocking and signaling plant. 1800 w. Eng Rec—April 17, 1909. No. 4010.

Block Signals in Des Moines, Iowa. Diagrams and description of a reliable block

We supply copies of these articles. See page 483.

and danger signal in use. 1200 w. Elec Ry Jour—April 10, 1909. No. 3824.

Washington Station Signal System. Brief illustrated description of the upper quadrant or three-position signal system installed. 1500 w. Ry & Loc Engng—April, 1909. No. 3656 C.

The Martin Alternating-Current Inductor Train Staff System (Mit Wechselstrom-Induktoren betriebene Zugstabeinrichtung, Bauart L. Martin). L. Kohlfürst. Illustrated description. Serial. 1st part. 3000 w. Schweiz Bau—March 13, 1909. No. 4267 B.

The Lartigue Electric Semaphore (Electro Sémaphore Système Lartigue). J. A. Montpellier. Illustrated description. 3000 w. Elecn—March 13, 1909. No. 4224 D.

Some Applications of Electricity in Railway Service (Quelques Applications de l'Electricité au Service des Chemins de Fer). J. A. Montpellier. Describes various signalling devices. Ills. 5200 w. Elecn—March 27, 1909. No. 4226 D.

MOTIVE POWER AND EQUIPMENT.

Car Ferries.

See Ferry Boats, under MARINE AND NAVAL ENGINEERING.

Car Oscillation.

The Oscillation of Articulated Cars (Untersuchungen über das unruhige Laufen der Drehgestellwagen). Herr Waddigen. A mathematical investigation of the causes. Ills. 3000 w. Glasers' Ann—March 1, 1909. No. 4274 D.

Couplers.

The Vinzio Semi-Automatic Coupler for Railway Cars (Attelage partiellement automatique pour Vagons de Chemin de Fer, Système Vinzio). Illustrated description. Serial. 1st part. 1200 w. Bul Tech d l Suisse Romande—March 25, 1909. No. 4227 D.

Electrification.

The Approaching Transfer of the Electrification Problem. General discussion. 12500 w. Pro N Y R R Club—March 19, 1909. No. 3933.

Some Notes on Railroad Electrification Matters. C. L. de Muralt. An explanation of the differences in continuous current, single phase and three phase systems. 2000 w. Mich Tech—Feb., 1909. No. 4069 D.

Proposed Electrification of Part of the Grand Trunk Pacific. Editorial on the proposal to electrify the portion of the line between the St. Lawrence River and Moncton, New Brunswick. 1000 w. R R Age Gaz—April 30, 1909. No. 4364.

Electrification of the State Railways of Italy. Extracts from information supplied by the general director of the State Railways of Italy. Maps. 3000 w. Engr, Lond—April 16, 1909. No. 4304 A.

Locomotive Fireboxes.

Jacobs-Schupert Locomotive Firebox. H. W. Jacobs. Illustrated description of construction, with explanation of advantages. 2500 w. Boiler Maker—April, 1909. No. 3830.

Locomotive Flues.

See Shops, under MOTIVE POWER AND EQUIPMENT

Locomotive Fuels.

Fuel Economy in Six Propositions. W. B. Landon. States the propositions, discussing each, and gives a number of chemical analyses. Relates to fuel for railways. 2500 w. Ry & Engng Rev—April 3, 1909. No. 3747.

The Employment of Liquid Fuels on Locomotives (L'Impiego del Combustible liquido sulle Locomotive). Giulio Pasquali. The first part begins a description and discussion of burners. Ills. Serial, 1st part. 1000 w. Ing Ferro—March 16, 1909. No. 4246 D.

Locomotives.

Benjamin Hick's Locomotives. Herbert T. Walker. Illustrated descriptions of engines built during the years 1834-37. 1800 w. R R Age Gaz—April 2, 1909. No. 3740.

Mallet Articulated Compound Locomotives for the Southern Pacific Co. Illustrated detailed description, giving principal dimensions. 1500 w. Ry & Engng Rev—April 24, 1909. No. 4183.

Mallet Articulated Compound Locomotive for the Southern Pacific. Plate and illustrated detailed description of engines intended for operation on a grade of 116 ft. to the mile, and expected to haul 1212 tons back of the tender. 3000 w. R R Age Gaz—April 30, 1909. No. 4366.

Baldwin 213-Ton Articulated Locomotive for Southern Pacific Ry.; the Heaviest Locomotive Ever Built. Illustrated datailed description of recently completed freight engines of great weight and size to use on heavy grades. 3000 w. Eng News—April 29, 1909. No. 4362.

Mallet Compound Locomotive for the Mexican Central. Illustrated description with dimensions. 700 w. R R Age Gaz—April 9, 1909. No. 3848.

Four-Coupled Ten-Wheel Side-Tank Locomotive; Ballycastle Railway. Particulars and illustrated description of an engine for service in Ireland. Plate. 400 w. Engng—March 26, 1909. No. 3790 A.

New Locomotives for the Federated Malay Railways. Illustrated detailed description of metre gage Pacific locomotives. 1200 w. R R Age Gaz—April 2, 1909. No. 3738.

Heavy Passenger Locomotives of the 4:6:2 Class; Western Railway of France. Illustrated description, with dimensions. 1200 w. Eng News—April 29, 1909. No. 4356.

The Latest Locomotives of the Orleans Railway (Note sur les derniéres Locomo-

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tives puissantes de la Compagnie d'Orléans). Th. Laurent. Illustrated detailed description of powerful Pacific, 4-cylinder compounds, with operating results. 5000 w. Rev Gen des Chemins de Fer—March, 1909. No. 4220 G.

Locomotive Smoke.

The Smoke Nuisance and the Railroads. A. W. Gibbs. Abstract of paper prepared for the Am. Civic Fed. Considers the subject from the economical and geological standpoint. 4000 w. Sci Am Sup—April 24, 1909. No. 4113.

Locomotive Tests.

Indicator Tests and Starting Gear of the 2-5 Four-Cylinder Express Compound Locomotives of the Danish State Railway. O. Busse. Diagrams and observations recorded are discussed. Ills. 1700 w. Bul. Int Ry Cong—March, 1909. No. 3956 G.

See also Ergometer, under MECHANICAL ENGINEERING, MEASUREMENT.

Locomotive Valve Gears.

Setting Valves on Locomotives with Walschaert Gear. Oscar Antz. Directions for laying out the gear on each locomotive. Diagrams. 1000 w. Am Engr & R R Jour—April, 1909. No. 3797 C.

Passenger Cars.

The Use of Steel in Passenger Car Construction. John McE. Ames. Discusses why steel should be used in passenger construction, and where, with related matters, cost, etc. General discussion. 8500 w. Pro Cent Ry Club—March 12, 1907. No. 4082 C.

The Queen's New Saloon. Illustrated description of a new Royal car for the North-Eastern Railway. 1200 w. Engr, Lond—March 26, 1909. No. 3793 A.

Refrigeration.

Mechanical Refrigeration in Railway Transportation. Joseph Hart. A discussion of the present situation from the point of view of the railway, and from a refrigerating viewpoint. 4000 w. R R Age Gaz—April 2, 1909. No. 3741.

Repair Card.

Abuse of the M. C. B. Repair Card. A general discussion. 3000 w. Pro N Y R R Club—March 19, 1909. No. 3932.

Sanding Devices.

A Locomotive Sanding Device (Un Appareil pour le Sablage des Roues de Locomotives). E. Sauvage. Illustrated description of a device invented by M. Lambert. 1500 w. Bul Soc d'Encour—Feb., 1909. No. 4216 G.

Shops.

A Study of the Number and Kind of Machine Tools Required in a Railway Locomotive Machine and Boiler Shop. L. R. Pomeroy. Presents a scheme for determining the kind and number of machine tools required to furnish a desired output. 4500 w. Am Engr & R R Jour—April, 1909. No. 3796 C.

Handling Locomotive Tubes. Illustrated description of the manner in which flues are being worked in a B. & O. shop at Garrett, Ind., which turns out repaired boiler tubes at the rate of one a minute. 1000 w. R R Age Gaz—April 9, 1909. No. 3845.

New Locomotive Repair Shops of the Grand Trunk, Battle Creek, Mich. Illustrated detailed description of the shops and their equipment. Plate. 4000 w. R R Age Gaz—April 16, 1909. No. 3981.

A Study of the General Arrangement of the Beech Grove Shops. Plan, sections and description of shops for the C. C. C. & St. L. Ry. near Indianapolis. 1500 w. Am Engr & R R Jour—April, 1909. No. 3798 C.

Train Resistance.

Some Recent Train Resistance Formulae. Lawford H. Fry. Gives for comparison, formulae developed from recent tests on the Continent, describing some of the methods employed. 3500 w. Engr, Lond—March 26, 1909. Serial. 1st part. No. 3791 A.

Graphic Presentation of Train Resistance Formulas. Sidney C. Carpenter. Table and diagram with explanation. 300 w. R R Age Gaz—April 30, 1909. No. 4368.

PERMANENT WAY AND BUILDINGS.

Ballast.

The New Road Ballast of the Union Pacific Railroad. Eliot Blackwelder. Gives an analysis of the material used for ballast on this fine road. Ills. 1000 w. Wis Engr—Feb., 1909. No. 4315 D.

A Gravel Washing Plant on the Richmond, Fredericksburg and Potomac R. R. E. M. Hastings. Illustrated detailed description of a plant for the purpose of washing gravel for ballast. 1800 w. Eng News—April 15, 1909. No. 3978.

Gravel Washing Plant, Richmond, Fredericksburg & Potomac R. R. Illustrated description of this washing plant, with editorial on materials used for ballast. 3000 w. Ry & Engng Rev—April 10, 1909. No. 3879.

Construction.

Railway Construction Notes. F. Pardoe Wilson. Notes on shrinkage and overhaul, road crossings, etc. 1500 w. Can Soc of Civ Engrs—April 15, 1909. No. 4321 N.

A Traveling Bridge Suspended from a Cableway for Making Fills. Illustrated description of apparatus being used on the big fills of the D. L. & W. cut-off near Blairstown, N. J. 1200 w. Eng News—April 22, 1909. No. 4157.

The Construction of the Hopatcong-Slateford Low-Grade Cut-Off of the Lackawanna Railroad. Illustrated description of the construction work which

will cost about $333,000 per mile. 4500 w. Eng Rec—April 17, 1909. Serial. 1st part. No. 4009.

Crossings.

The Disadvantages of Concrete Foundations for Railway Crossings. R. P. Black. Gives experience with such foundations and reasons for considering them a failure. Ills. 800 w. Eng News—April 29, 1909. No. 4360.

Grade Crossing Elimination. A. D. Chidsey, Jr. Gives a condensed summary of the status of grade crossing abolition, covering legislation, amount of work, and costs. 1800 w. Eng News—April 1, 1909. No. 3759.

Abolition of Railroad Grade Crossings in Philadelphia. Describes work of elevating tracks which will cost about $10,000,000. Ills. 3000 w. Eng Rec—April 17, 1909. No. 4015.

Elevated Railways.

Big Four Track Elevation at Indianapolis. Illustrated description of important track elevation, as a part of plan to eliminate grade crossings. 1200 w. R R Age Gaz—April 23, 1909. No. 4153.

Elevating Tracks of the Philadelphia, Baltimore & Washington Railroad Through Wilmington, Del. H. S. Righter. A description of this work. 2500 w. Pro Engrs' Club of Phila—Oct., 1908. No. 4323 D.

Embankments.

Holding Railway Banks With Grass. L. H. Pammel. Reports success with different kinds of grass. Ills. 1200 w. R R Age Gaz—April 2, 1909. No. 3736.

Grade Reduction.

Grade and Line Revision, and a Concrete Voussoir Arch Bridge; Cumberland Valley Ry. Illustrates and describes improvements for the elimination of a pusher grade, as well as reduction of grades and curvature, and including a 100 ft. span concrete arch. 800 w. Eng News—April 8, 1909. No. 3851.

Location.

General Instructions to Locating Engineers, Alaska Central Railway. Instructions prepared by G. A. Kyle to govern surveys. 10500 w. Engng-Con—April 21, 1909. No. 4152.

Rails.

Rolled Manganese Steel Rails. Illustrated article giving information concerning the rolling of the Manard rail of the Pennsylvania Steel Co., and the testing machine. 1600 w. Ir Age—April 22, 1909. No. 4097.

Roundhouses.

Engine Terminal Requirements. A. O. Cunningham. Discusses the design, arrangement, and cost. 2500 w. Minn Engr—March, 1909. No. 4068 C.

Labor and Time Saving Devices in the Roundhouse. Illustrates and describes devices selected from the McKees Rocks roundhouse of the Pittsburg & Lake Erie R. R. 1600 w. Am Engr & R R Jour—April, 1909. No. 3800 C.

Stations.

Union Passenger Station at Salt Lake City. Illustrated description of a reinforced concrete structure on pile foundations. 2000 w. Ry & Engng Rev—April 17, 1907. No. 4052.

Terminals.

Steel Construction in the New York Terminal of the New York Central & Hudson River Railroad. Outlines the general character of the terminal yards and illustrates and describes features of the steel structures. 3800 w. Eng Rec—April 10, 1909. No. 3859.

Track Construction.

Practical Railway Track Work. K. L. Van Auken. The present article considers double-tracking and relaying track. 4500 w. Serial, 1st part. Wis Engr—Feb., 1909. No. 4316 D.

Bush Track Construction. Illustrated description of track structure in the Bergen Hill tunnel, Jersey City, N. J., of the D. L. & W. Ry., invented by Lincoln Bush. 2500 w. R R Age Gaz—April 23, 1909. No. 4154.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

TRAFFIC.

Car Interchange.

Freight-Car Distribution in the Prussian State Railways Car Association (Die Güterwagenverteilung im preussischen Staatsbahnwagenverbande). Herr Grunow. Describes the method of car interchange. Ills. Serial. 1st part. Glaser's Ann—March 1, 1909. No. 4273 D.

Mail Carrying.

Railway Mail Pay. Julius Kruttschnitt. Reviews legislation and reduction of rates during the last ten years, giving receipts and other information. 3500 w. R R Age Gaz—April 9, 1909. Serial. 1st part. No. 3846.

Mineral Products.

See Transportation, under MINING AND METALLURGY, MISCELLANY.

MISCELLANY.

Arabia.

The Hedjaz Railway (Die Hedschasbahn). Herr Denicke. Describes the line, rolling stock, etc. Ills. 4000 w. Glaser's Ann—Feb. 15, 1909. No. 3395 D.

Australia.

A Utopian Railway Project. Robert W. Wilson. An explanation of the railway situation in Australia. 1500 w. R R Age Gaz—April 9, 1909. No. 3847.

Boston.

Report of the Boston Metropolitan Improvements Commission. Gives the recommendations of the commission of a

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proposed development of the present steam railway systems of the Boston terminal district. Ills. 3000 w. R R Age Gaz—April 23, 1909. No. 4155.

British Columbia.

The Railways of British Columbia. Brief reports of progress on the Grand Trunk Pacific, Canadian Pacific, and Canadian Northern. 2500 w. R R Age Gaz—April 2, 1909. No. 3739.

China.

The Railways of China. Information concerning the actual construction and lines projected, with statement of the nations furnishing the capital and responsible for the management of the railways after construction. Map. 2200 w. Engr, Lond—March 12, 1909. No. 3423 A.

Colombia.

The Dorada Railway Extension in Colombia. An explanation of conditions and of the inaccessible locations chosen for the capital cities of South America, and an illustrated description of an extension of 50 miles recently constructed to connect Cambao with Honda. 1800 w. Engr, Lond—March 12, 1909. No. 3426.

Costa Rica.

Railroad Construction and Harbor Work in Costa Rica. Substance of a paper by William D. Janney, read before the Engineers' Club of Baltimore, describing the construction of a railroad and improvement of harbor facilities. Ills. 2000 w. Eng Rec—March 20, 1909. No. 3272.

England.

The Railway Situation. Editorial review of the returns of the English railway companies for the second half of 1908, and matters related. 2200 w. Engng—Feb. 26, 1909. No. 3067 A.

France.

Lines of Local Interest in France. C. Colson. Discusses the French local railways and rural tramways in 1907, the urban railways and tramways, and the proposed French statute concerning lines of local interest. 7500 w. Bul Int Ry Cong—Feb., 1907. No. 3282 G.

The Legislation Affecting the Lines of Local Interest (Note sur la Législation des Voies Ferrées d' Intérêt local). A. Doniol. A discussion of the recent law. 12000 w. Rev Gen des Chemins de Fer—Feb., 1909. No. 3324 G.

German West Africa.

The Lüderitzbucht-Keetmanshoop Railway in German Southwest Africa (Die Bahn von Lüderitzbucht nach Keetmannshoop in Deutsch-Südwestafrika). Herr Friedrich. Illustrated description of the line, rolling stock, construction work, etc. 5000 w. Glaser's Ann—March 15, 1909. No. 4276 D.

Government Control.

Public Regulation and Control of Railways. Frederic A. Delano. An address before the Hannibal (Mo.) Commercial Club. Considers present conditions of railway business, and discusses the remedies suggested. 3500 w. R R Age Gaz—April 16, 1909. No. 3982.

Management.

Methods of the Santa Fé. Efficiency in the Manufacture of Transportation. Charles Buxton Going. This third article of a series deals with the manufacturing policies for the economical maintenance of motive power. Ills. 4000 w. Engineering Magazine—May, 1909. No. 4344 B.

Mexico.

The Railroad Systems of Northern Mexico. H. A. Horsfall. Map and discussion of the railroads in operation and under construction. 1500 w. Eng & Min Jour—April 3, 1909. No. 3728.

Pennsylvania.

Pennsylvania Railroad. Information in regard to the business of this great railroad. 2000 w. R R Age Gaz—April 30, 1909. No. 4365.

Valuation.

Report of H. P. Gillette to the Washington Railroad Commission on the valuation of the railways in Washington. 5000 w. Engng-Con—April 7, 1908. Serial. 1st part. No. 3872.

Railway Capital and Values. W. H. Williams. An address before the N. Y. Traffic Club. Discusses and criticizes methods of valuation of railway property. 3000 w. R R Age Gaz—April 2, 1909. Serial. 1st part. No. 3742.

STREET AND ELECTRIC RAILWAYS

Boston.

Report of the Boston Metropolitan Improvement Commission. Abstract of a report particularly considering transportation problems. Also editorial. 6000 w. Eng News—April 1, 1909. No. 3763.

Car Barns.

See same title, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Car Maintenance.

Mechanical and Electrical Practices at Harrisburg, Pa. Illustrated description of features of maintenance practice. 3000 w. Elec Ry Jour—April 3, 1909. No. 3666.

Methods and Costs of Inspection and Repair Work on the South Side Elevated Railroad. An effective record system used in Chicago is described and some

figures of cost given. 2500 w. Elec Ry Jour—April 3, 1909. No. 3667.

See also Shops, under STREET AND ELECTRIC RAILWAYS.

Car Wiring.

Fire Risks in Heavy Car Wiring and Control. Criticises prevailing methods and suggests the use of grooved slabs of asbestos slate, and placing the whole control apparatus in a fireproof compartment. 2000 w. Elect'n, Lond—April 9, 1909. No. 4025 A.

Cuba.

Electric Traction in Cuba. Brief illustrated description of the lines of the Havana Central R. R. Co. 1200 w. Tram & Ry Wld—April 1, 1909. No. 3985 B.

Electric Traction.

Calculations for Traction Projects (Les Méthodes de Calcul des Projets de Traction). M. Parodi. Describes the author's methods of solving motor and train-movement problems. Ills. 10800 w. Bul Soc Ind d'Elecns—March, 1909. No. 4209 F.

Havana.

The Havana Central Railroad. Reginald Gorham. Brief illustrated description of an up-to-date long-distance electric railway. 700 w. Elec. Wld—April 15, 1909. No. 3942.

Interurban.

Maintenance and Improvements on the Illinois Traction System. Treats of maintenance, methods, organization, traffic, and extension of lines. Ills. 5400 w. Elec Ry Jour—April 17, 1909. No. 3967.

London.

The Electrical System of the London County Council Tramways. John Hill Rider. Describes the development of the undertaking and the equipment of the Greenwich generating station. Gives cost details. Ills. 13500 w. Inst of Elec Engrs—April 1, 1909. No. 3775 N.

Mexico City.

Conditions of Electric Railway Operation in Mexico City. An illustrated article describing the character of the population and features of the tramway system. 3500 w. Elec Ry Jour—May 1, 1909. No. 4371.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Rail Bonding.

Autogenous Rail Welding (Autogene Schienenschweissung). Theo. Kautny. Describes and compares with regard to efficiency the mechanical, thermit, and blowpipe methods. Ills. 3000 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens—March, 1909. No. 4248 F.

Railless.

Electric Trolley Automobiles (Elektrische Oberleitungs- Automobillinien). Ludwig Stoll. Illustrates and describes several European railless electric-traction systems. 4000 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens—March, 1909. No. 4247 F.

Shops.

Shops and Equipment Maintenance of the Illinois Traction System. Illustrates and describes the new shops at Decatur, and outlines the standardization work. 2500 w. Elec Ry Jour—April 3, 1909. No. 3669.

The Reconstructed Car House and Shops of the Third Avenue Railroad Company. Illustrated description of features of the recently completed reconstruction at the 66th Street shops. 3500 w. Elec Ry Jour—April 3, 1909. No. 3664.

Signaling.

Signaling of the Brooklyn Bridge and Its Manhattan and Brooklyn Terminals. Illustrated detailed description of the special system of automatic signaling installed. 2200 w. Sig Engr—April, 1909. No. 3998.

Street Railway Interlocking at Washington. Illustrated description of system installed. 800 w. R R Age Gaz—April 2, 1909. No. 3737.

Electric Interlocking and Signaling System for the Street Railways at the Union Station Plaza, Washington, D. C. Illustrated detailed description of the scheme. 3000 w. Eng News—April 15, 1909. No. 3980.

Single Phase.

Electric Traction by Simple Alternating Current on European Railways. H. Marchand-Thiriar. Particulars in regard to the Seebach-Wettingen line. 3500 w. Bul Int Ry Cong—March, 1909. No. 3957 G.

The Chicago, Lake Shore & South Bend Railway. Illustrated detailed description of an important single-phase installation extending from South Bend, Ind., to Pullman, Ill. 4000 w. Elec Ry Jour—April 10, 1909. No. 3823.

Switzerland.

The Chamonix Martigny Electric Railway. C. Van Langendonck. Illustrated description of a narrow-gage line through the Alps from France into Switzerland. 1000 w. R R Age Gaz—April 30, 1909. No. 4360.

Trolley Lines.

The Connecticut Company's Standards for the Overhead Construction of 500-Volt, D. C. Railways. Drawings and abstract of specifications. 4000 w. Elec Ry Jour—April 3, 1909. No. 3665.

Tunnels.

Brief illustrated description. 1000 w. of Great Northern Railway (U. S. A.).

Electric Traction in the Cascade Tunnel Tram & Ry Wld—April 1, 1909. No. 3986 B.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Der Motorwagen. *s-m.* Berlin.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.